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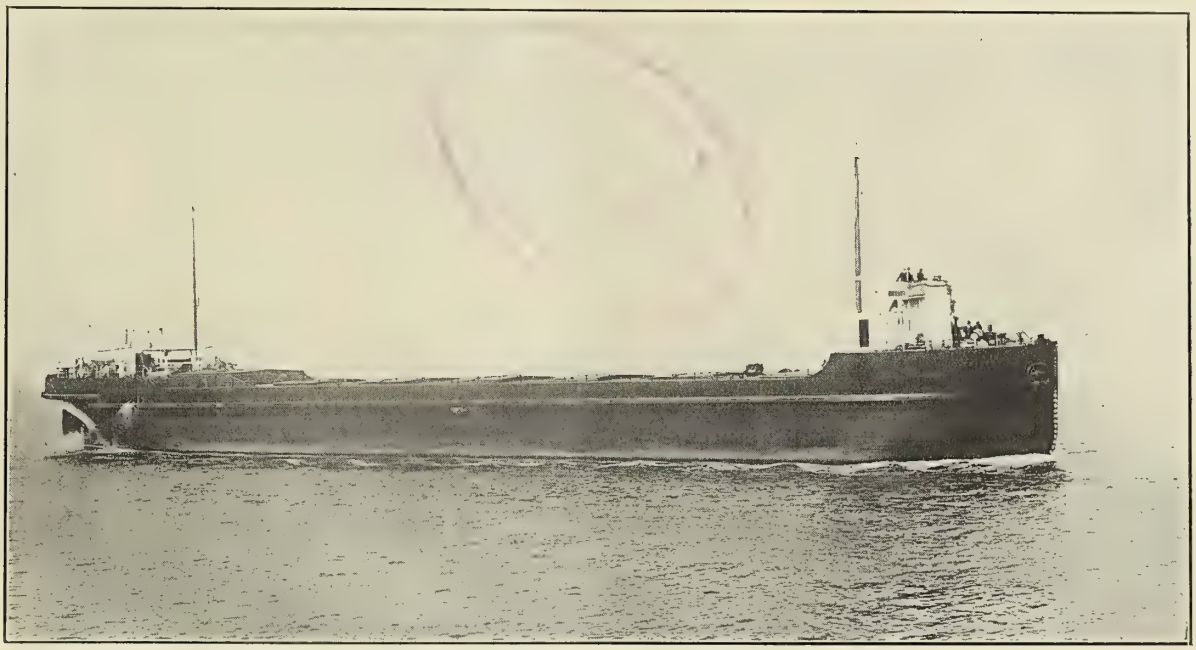
TOILER, A DIESEL OIL-ENGINED VESSEL OF 2,700 TONS.

BY J. RENDELL WILSON.

During the past twelve months wonderful strides have been made with the Diesel type of crude oil engine, in connection with marine work, in Great Britain and on the Continent. Not only in government dockyards but also in private shipyards much experimental work has been carried out in secret. To a certain extent it has been known that large marine oil engines were being built; but reliable data have been lacking and many rumors current. For instance, it is now fairly well known that the German battleship *Goeben*, which is now completing, has her central shaft driven by 12,000-horsepower Diesel motors, but further figures and official assention, or denial, are unobtainable. So far only two full-powered motor vessels of really large dimensions have undergone trials, one being the 1,000-ton oil carrier *Vulcanus*, owned by the Anglo-Saxon Petroleum Company, which has proved to be a great success, and has caused her owners to order another oil-engined vessel of more than twice her horsepower.



2,700-TON VESSEL, TOILER, DRIVEN BY TWO 180-BRAKE-HORSEPOWER DIESEL OIL ENGINES.

Of the other boat, full details have been carefully held back by her owners until she should have proved her worth, and only now have they been supplied. The vessel to which I refer is the *Toiler*, built for service on the Canadian lakes and canals by Messrs. Swan, Hunter & Wigham Richardson, Ltd., at their Neptune Works, Newcastle-on-Tyne. She has just successfully accomplished a maiden voyage from the firm's yard to Calais and back. She is by far the largest craft of her type actually afloat, and should do much to remove the prejudice still held by many shipping firms. The *Toiler* is a twin-screw vessel, 248 feet in length between perpendiculars, by 42½ feet beam, with 19 feet molded depth and 14 feet loaded draft. She is fitted with two 180 brake-horsepower reversible Diesel four-cylinder oil engines of the two-cycle type, with bore of 9.85 inches and stroke of 14.6 inches, which were constructed by the Diesel Motoren Company, Stockholm, and installed by the builders of the hull. Power is developed at 250 revolutions per minute, and is equivalent to about 400 indicated horsepower. It has been found necessary only to fit this comparatively low power, as speed on the Canadian canals is naturally restricted. In view of the fact that she is funnelless she has rather a striking appearance, especially as three-quarters of her central length is entirely free from deck work. The bridge and part of the accommodation are forward, while the engine-room and remainder of the crew space are at the after end. Aft of the raised deck forward a short mast is stepped, and another aft the holds. Access is obtained to the latter by six large hatches.

On her voyage to Calais she was loaded with 2,650 tons deadweight of coal cargo in addition to 40 tons of oil fuel, yet her mean draft was only 14 feet, as the machinery weighs 60 tons less than a corresponding steam plant. She left the Tyne in very rough weather, and completed her voyage at an average speed of 5.9 knots (6¾ miles per hour), her engines running like clocks throughout. On the return voyage, when running light, her average speed was 8.2 knots (9½ miles per hour). Throughout the round cruise the consumption of fuel, including that for the auxiliary compressor, was only 6½ tons; that is, 1.7 tons per 24-hour-day of 18,000 British thermal units calorific valve oil. On fuel alone the saving over steam engines of the same horsepower is considerable. In the case

of the *Toiler* the cost of the oil consumed per diem works out at about £3 5s. ($15.60), whereas steam engines would require at least 9 tons of coal per diem, at, say, 12s. ($3) per ton = £5 8s. ($28). Thus on fuel alone there is a saving of over £2 ($10) per day, a considerable item. But this is by no means all, as the stokers are dispensed with, and apart from the cost of their food a total of over £1 ($5) per day would be saved on the wages bill, and their accommodation given over to extra cargo space.

Another important item about the economy of the *Toiler* is, that owing to the absence of boilers and bunker space, a much greater space is given over to the hold, which increases her earning powers.

The oil fuel is carried in the double bottom in place of water ballast, and comparing weight for weight with coal only one-fourth is required, thus increasing her deadweight capacity by about 120 tons; *i. e.*, again increasing her earning powers per voyage. Shipowners are now realizing these facts, and half a dozen more orders have already been placed in Great Britain and nearly one hundred on the Continent. During the past six months about thirty Diesel building licenses have been granted in the former country to such firms as Babcox & Wilcox, the British Westinghouse Company, Vickers, Ltd., Palmer's Shipbuilding Company, J. I. Thornycroft & Company, Richardson Westgarth & Company, Willans & Robinson, and many other famous engineering firms.

Returning to the *Toiler,* all the deck machinery, winches, etc., and the engine-room accessories are worked by compressed air, the compressor being driven by a small Diesel engine. Electric light is installed throughout, the dynamo being driven by a small paraffin-oil motor. Principally the cabin heating arrangements are by hot water heated by the exhaust gases, although in some cases there are small coal stoves. So it will be seen that steam as a driving power has entirely been dispensed with. On the whole, Messrs. Swan, Hunter & Wigham Richardson are to be congratulated on their enterprise. Another, but larger, motor vessel may soon leave their slips, as the firm is already at work on a set of big four-cylinder engines of the two-cycle type.

ELECTRICAL PROPULSION OF VESSELS.

Proposed utilization of electricity for ship propulsion consists primarily in the conversion of mechanical work developed by prime movers, such as steam turbines or internal-combustion engines, into electrical energy by means of generators, and the reconversion of the electrical energy into mechanical work by means of motors, which finally transmit rotary motion to the propellers. It is somewhat difficult at a first glance to see that such a combination of systems possesses advantages over direct turbine or engine drives, owing to the apparent complications and the not immaterial loss of efficiency at the various stations for power conversion. Be that as it may, however, a portion of the doubt will be dispelled by baring the facts which may be responsible for the results in electric installations for propulsive purposes, should such become in more general use. Reasons for the adoption of turbo-electric drives as substitutes for direct-turbine drives may be considered from the following viewpoints, namely, that the turbine is:

1. Unsuitable for small power such as is used in the majority of slow craft for cargo-carrying purposes.
2. Necessarily limited in revolutions to obtain good propulsive efficiency, the speed of ships being largely the governing factor.
3. Necessarily large of dimensions, inefficient and heavy in weight when limited by revolutions.
4. Rapidly depreciating in steam economy when working below full power and speed.
5. Below desirable power for backing.
6. Necessarily provided with large blade clearances to allow for expansion and contraction in heating up, starting and backing.

Furthermore, the secret of the advantage seems to rest in the difference in the turbine when used as a direct drive and when used in connection with generators and motors. In the former instance is used a very large, heavy and comparatively slow-moving as well as inefficient turbine, while in the latter a light, simple, high-speed and highly efficient turbine is used. By nature of the motor and generator combination a comparatively slow-moving propeller, giving a considerably increased propulsive efficiency, is also obtained, of which, as an illustration, the following may be cited: The relative propulsive efficiency of propellers absorbing practically the same power, but running at, respectively, 130 and 330 revolutions per minute, will be 68 percent approximately in the former case while only 52 percent in the latter.

The combination referred to may also find suitable application in very large installations, owing to the fact that the reciprocating engine seems to be at its practical limit of size and speed at between 16,000 to 18,000 horsepower and piston speeds above 1,200 feet per minute.

The most important application of electric drives for propulsive purposes is found at the present time in submarines when they are running submerged. During this state of operation only the electric motors are in use, owing to the impossibility of securing sufficient air to work the internal-combustion engines, and also because of the difficulty in getting rid of the dangerous gases of combustion that are apt to leak through joints and stuffing-boxes.

Actual Installations.—Among such installations we find a submarine salvage ship built by Howaldt Werke, in Kiel, for the German navy. This ship is equipped with two turbo-dynamos of together 1,200 horsepower, running at 2,500 revolutions per minute. The dynamos are located on the lower deck and supply current to motors placed aft. The motors drive the propellers and develop about 600 horsepower on each shaft when running 200 revolutions per minute, giving a speed of between 11 and 12 knots to the ship.

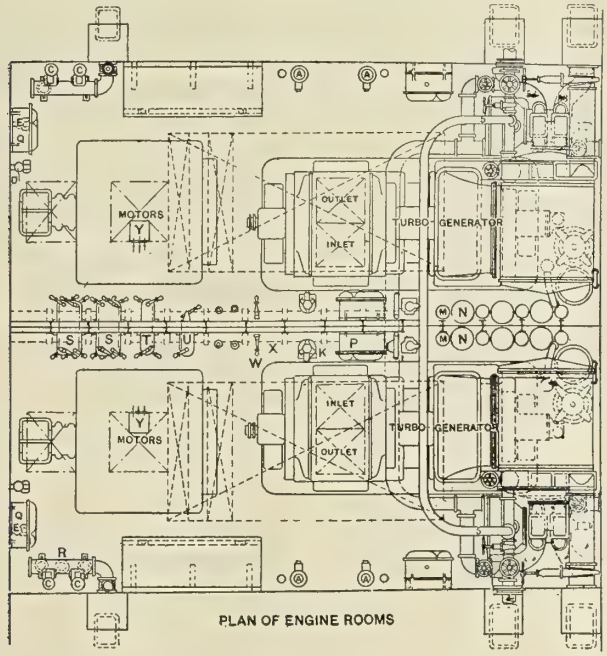
Other electrically-propelled vessels are two fire-boats used by the city of Chicago, Fig. 2. These vessels are propelled by direct-current electric motors, the power being obtained from generators direct connected to the steam turbines, which are used to drive the centrifugal fire pumps. These boats have been used for about three years, and have met with considerable success. The control of the machinery is mainly from the bridge.

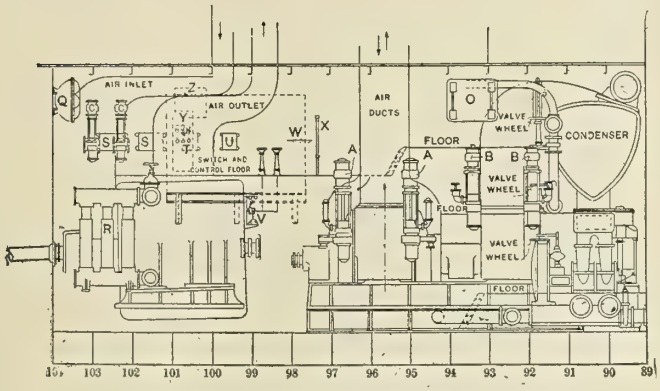
In submarines as now built the driving power is electricity when running submerged, and by internal-combustion engines when running awash. The electric drive consists essentially of motors and storage batteries, composed of cells which have a certain ampere-hour capacity at a normal rate of discharge. The charging of the batteries is done by the motors, acting as generators, driven by the engine when the boat is lying at the dock or in surface operation. The armature shaft of the motors are connected to the engine shaft by a clutch coupling, and when only the engines are being used for propulsion the armature revolves freely with brushes lifted and serves as a fly-wheel.

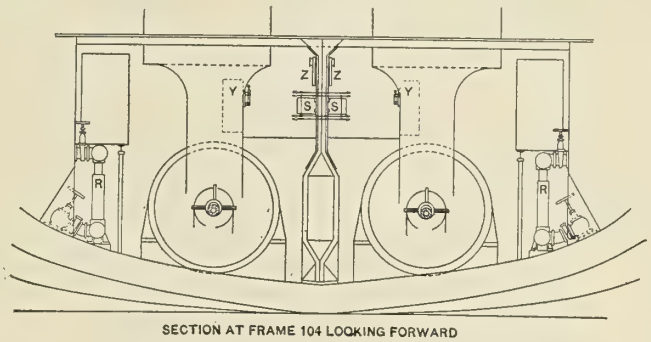
Advantages offered by electric power for submarine use are:

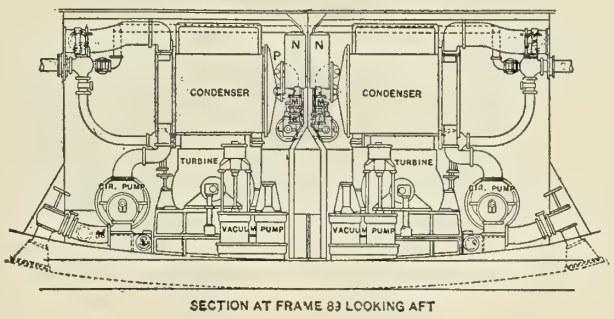
1. Uniform weight during the entire period of operation.
2. Quietness during operation.
3. No development of heat and only slight deterioration of the atmosphere.

The electric motors used are of the multi-polar type, with either compound or derived windings. They operate at uniform speed with constant current. Speed variation is secured by interposing a resistance in the field, or, when a great speed variation is required, a change of voltage by sub-dividing the batteries is resorted to. The voltage maintained is low, and ranges between 150 to 200 volts, owing to the difficulty in maintaining satisfactory insulation. The batteries, or accumulators, are usually of the sulphuric acid type. They are generally made with ebonite cells, some hermetically sealed, others not sealed, the acid being then carried at such a level as not to be spilled by the rolling of the vessel. The removal of the gases evolved from the batteries is of considerable importance. These gases, consisting as they do of oxygen and hydrogen in such quantities as to form an explosive mixture, are not only dangerous as such but are injurious to inhale and have a corrosive effect on the machinery.









Auxiliaries.

A. Main feed pumps.
B. Fire and bilge pumps.
C. Forced lubrication service pumps.
D. Fuel oil pumps.
E. Oil cooler circulating pumps.
F. Pipe insulator circulating pumps.
K. Auxiliary air pumps.
L. Auxiliary circulating pumps.
M. Air compressors.
N. Compressed air tanks.
O. Feed heaters.
P. Auxiliary condensers.
Q. Oil coolers.
R. Water rheostat.
S. Motor switches.
T. Generator switches.
U. Tie switch.
V. Pole-changing switches.
W. Hydraulic gear operating wheels.
X. Liquid tachometer.
Y. Field rheostat.
Z. Switch panel.

FIG. 1.—PROPOSED TURBO-ELECTRIC PROPULSION OF BATTLESHIPS OF THE DELAWARE TYPE.

PROPOSED INSTALLATIONS.—Complete designs with some of the more essential appurtenances worked out in detail have been proposed by W. L. R. Emmet, of the General Electric Company, and have been described by him in a paper read before the American Institute of Electrical Engineers, and published in the proceedings of said institute. The following is an abridged abstract from said paper: For a battleship design of the *Delaware* and *North Dakota* type it is proposed to use two shafts, and to install in each engine room one turbine-driven generating unit with a capacity of about 1,200 kilowatts, with induction motors, suitable instruments and switching devices, and a group of water-cooled resistances for use when reversing the motion. The generating units will have ample provision for possible overload. The generators are four-pole alternators, designed to operate at a maximum potential of about 2,300 volts. The generator speed will be about 1,220 revolutions per minute for a speed of about 21 knots, the corresponding motor and propeller speed being about 160. Excess speed is guarded against by a controlling mechanism connected to the admission valves on the turbine. The governing mechanism is also actuated by a hand lever, by means of which the opening of the valves may be restricted. Each shaft is operated by two independent motors connected together in one compact unit. The stator of one motor is arranged for connection with either thirty or fifty poles, the former for high speeds the latter for cruising speeds; the other motor is designed without the pole-changing connection. A disconnecting switch for each generator and disconnecting and reversing switch for each motor is provided. In high-speed operations of the ship both generators and all four motors will be in use, the pole connections in the motors then being such as to admit of a speed reduction in the ratio of one revolution for the propellers to seven and one-half of the turbines.

The propellers may be started, stopped or reversed inde-

pendently while the generators are running. In this connection it is to be noted that the generators always run in the same direction, the different operations being performed with the motors. Speed reduction is accomplished by changing the steam admission to the power-generating units, just as is done in ordinary turbine installations, without, however, materially changing the speed of the turbine. Reversing is effected by introducing resistances in the motors arranged for reversing and to disconnect the other motors. The operation is accomplished by first opening the field circuit, then moving the switches and resistance devices into the proper positions, and then re-establishing the field circuit.

The following table will give some idea of the economy and

Knots	10	12	14
Motor speed	78.5	94.5	110
Generator speed	1,430	1,725	2,000
Estimated S. H. P.	2,550	4,350	6,900
Water rate in lbs. per S. H. P.	15.55	13.15	12.15

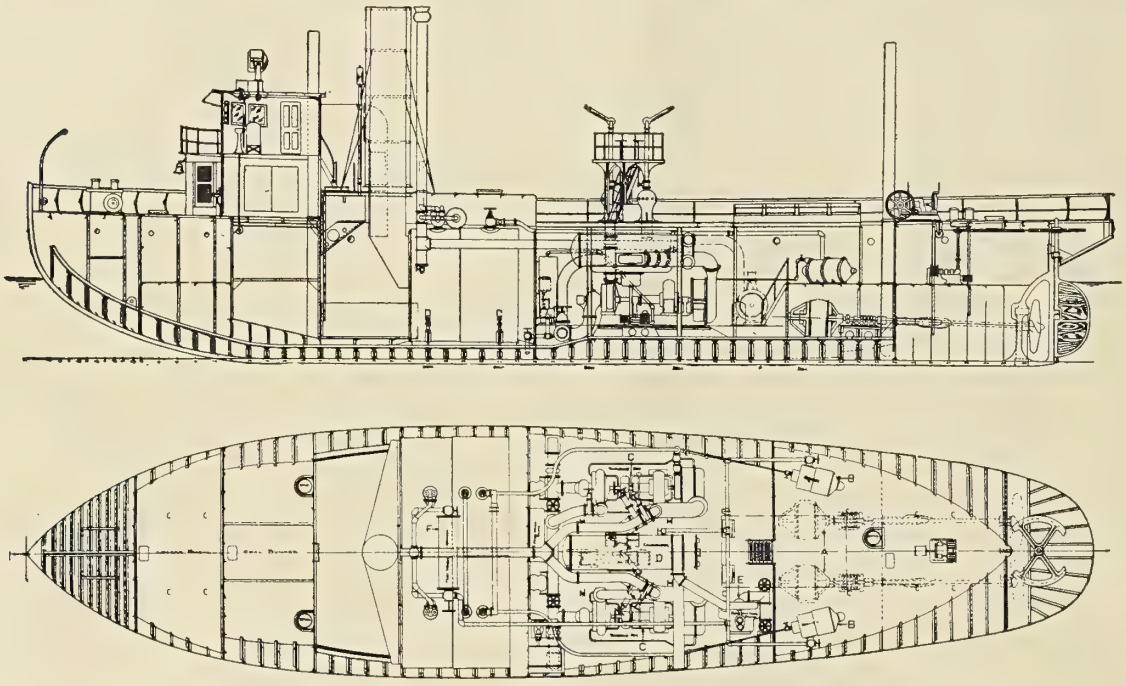


FIG. 2.—DIAGRAM SHOWING THE LOCATION OF THE PUMPING AND PROPELLING MACHINERY OF THE CHICAGO FIREBOATS.

speeds of rotation with an installation as described above. The results are based on 28 inches of vacuum, which seems a probable average for a good condensing outfit as now fitted in ships. The steam pressure is 265 pounds gage with 50 degrees of superheat:

Knots	12	16	18	19	20	21
Motor speed	87	117	132	140	149	160
Generator speed	1,110	895	1,010	1,072	1,140	1,220
Shaft horsepower	4,630	11,100	16,300	19,400	23,100	29,000
Pounds steam per S.H.P.	13.2	13.4	11.8	11.3	11.25	11.3

Fig. 1 illustrates the installation described.

Another installation with electric power, also described by Mr. Emmet in the paper previously referred to, is that for a collier of about the same power as the *Cyclops,* with reciprocating engines, and the *Neptune,* with Westinghouse turbines and mechanical gearing to reduce the propeller speed. The United States collier *Jupiter,* building at the Mare Island navy yard, would be a suitable ship for such an installation, and highly interesting by comparison with the other two mentioned colliers.

While the installation would in general be the same as for the battleship it may be made simpler owing to a lesser variety of conditions in service. One generating unit, with two motors having no arrangement for pole changing, but equipped with resistance attachment, would be installed. The ventilation of the apparatus is proposed to be effected by drawing air from the engine room, and after having passed through the apparatus to deliver the heated air to the blower suction, and finally discharging it to the boilers. Oil switches to connect the different parts of the apparatus would be used in this installation instead of, as proposed for the battleship, by interrupting the circuit when the connections are changed.

Reversing motion would be obtained by simply throwing the switch levers in either direction without interrupting the circuit or changing the turbine admission valves. The economy expected with an installation of the collier type, using dry saturated steam at 190 pounds gage pressure and a 28.5-inch vacuum, will be according to the following table:

REPAIRS.—It is claimed for the electric drive that the cost of operation and maintenance will be considerably less than with arrangements with reciprocating engines. The apparatus will involve no loss of oil and, as in ordinary turbine arrangements, admit but little oil to the boilers. The engine room force required will be only nominal, and will mainly be composed of those needed for the auxiliaries.

A system of electric propulsion has been devised by the British Westinghouse Company, in which motors of the alternating-current, three-phase squirrel-cage type, requiring neither commutators, slip rings, brushes, regulating switches nor resistances, are directly coupled to the propellers. Power for the motors is supplied by turbo generators, in which high-speed steam turbines are coupled to an alternating-current three-phase generator. The exciting current can be furnished by separate small generators, which would also supply current for other auxiliary purposes. Each motor is supplied with current by an independent line of three-phase cable, each cable passing through a simple reversing and isolating switch. The voltage of transmission could be selected at any value desired within reasonable limits.

The turbines are fitted with a very powerful brake, so constructed that on turning steam in to this part of the turbine sufficient resistance would be offered to the rotation of the drum to reduce its speed quickly.

In operating this system, it is only necessary to excite the

generators and open the steam valves of the turbines, when the motors will start up, with the generators running almost in synchronism with them until full speed is reached. The speed of the ship can be regulated by regulating the speed of the turbines, as is customary in turbine-driven ships. The difficulty in this system occurs when it is desired to stop the propellers from a considerable speed and reverse their rotation, as this cannot be done by simply throwing over the reversing switches, as this would bring about an excessive strain on both generators and motors.

According to the British Westinghouse Company's system, the change from full speed ahead to full speed astern is accomplished by shutting off steam from the working portion of the turbine and turning it into the steam brake. The motion of the ship in the ahead direction operating through the propellers drives the motors as generators, transmitting power back to the generator and thereby driving the turbine. This power is absorbed in the steam brake, where the surplus energy can be easily dissipated. The speed of the ship is thereby effectively and rapidly checked until the speed of the generator and motors has fallen to a point at which the frequency is sufficiently low to enable the reversing switch to be operated without causing excessive current. Steam is then immediately shut off from the brake and simultaneously admitted into the working portion of the turbine. At the reduced frequency, which the voltage applied to the reverse motors now has, the motors are able to develop full-load torque, with normal current, without the need of rotor resistances, consequently the ahead motion of the ship can be completely checked, and it can be started in the reverse direction.

ELECTRICALLY OPERATED AUXILIARY APPARATUS

BY M. W. BUCHANAN.

The size of the electric generating plant and the application of electric drive for auxiliary apparatus and machinery on board vessels has increased rapidly during the last few years. Modern battleships have practically all the auxiliaries outside the propelling machinery spaces, with the exception of the anchor windlass, steering gear and refrigerating machinery, operated by electric motors, and it is understood that provision has been made for the electrification of the last-named auxiliaries on future vessels.

The present standard generating plant for American battleships consists of four 300-kilowatt, 125-volt, direct-current turbo-generator sets, installed for protection, in two widely separated dynamo rooms below the waterline, each with its own condensing apparatus, and with means for supplying current to the distributing circuits from either dynamo room. The generators have an overload capacity for short periods of 33 1/3 percent, thus providing a maximum capacity of 1,600 kilowatts.

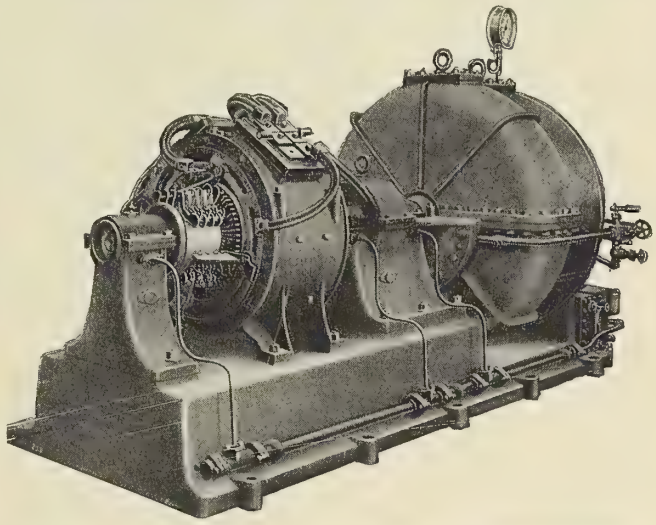
A drop of 5 volts is allowed on power circuits, and the motors are wound for 120 volts. This provides that the speed of motors shall not fall below that required due to low voltage at the motor terminals.

The total number of electric motors for driving auxiliaries on a modern battleship is about 250, which includes the handling of turrets, guns, ammunition conveyors and hoists, boat cranes, winches, elevators, pumps, watertight doors, cooking, heating and galley appliances, fans, tools, telephones, telegraphs and signaling apparatus.

MOTORS AND CONTROLLING APPLIANCES.

The nature of the service to which electrical apparatus is subjected on board naval vessels is such that certain special requirements with regard to construction and performance are specified apparatus in excess of those ordinarily prescribed for apparatus on shore. Several motors and their controlling appliances, such as those for operating boat cranes and deck winches, are exposed to salt water and sea air, requiring watertight construction of a high order and non-corrosive fittings; in fact, the atmospheric conditions and the dampness encountered even below decks have led to the adoption of non-corrosive fittings throughout for all shipboard electrical apparatus.

The intimate contact with the crew, numbering in the neighborhood of 1,000 men for large battleships, makes it necessary to exercise precaution against accidental or unauthorized interference with the electrical apparatus. To guard against this all controlling appliances are mounted in metal cabinets with locked doors, and the leads to the motors enter through covered connection boxes or in conduit tapped directly into the motor frame. Electrical apparatus mounted



ELECTRIC GENERATING SET WITH TERRY TURBINE AND DIEHL GENERATOR

in proximity to magazines and in ammunition passages are of flameproof and waterproof construction to the same extent as those exposed to the elements.

The extreme importance of military preparedness on board naval vessels makes it necessary to exercise extra precaution in the design and installation of electrical apparatus, which is so extensively used and upon which so much depends in action. In addition to the original specifications for this apparatus, it is further insured against failure by carrying upon each vessel a very complete set of electrical spare parts for each type of motor used, including armatures, field coils, brushes and brush holders, bearing linings, brush insulation, oil rings and gages, and spare parts for the controllers, including arcing contacts, sliding brushes, springs, solenoid coils and rheostat units.

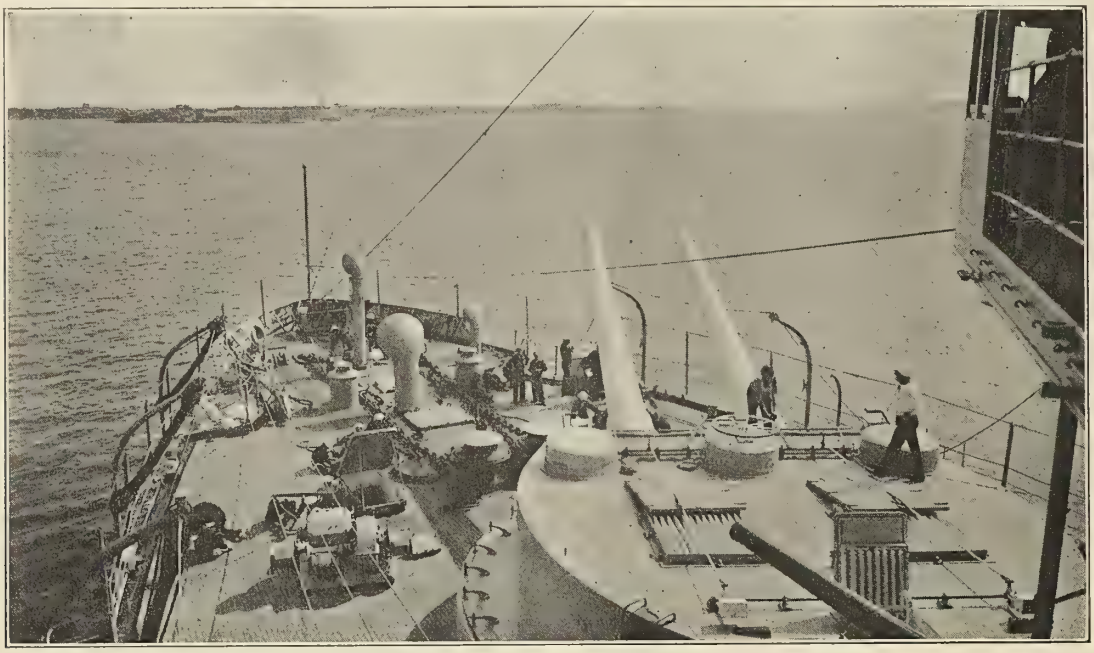
Full information regarding the construction of motors, controllers, rheostats and the testing of motors for United States naval vessels can be obtained from General Specifications No. 17-A-3 for Auxiliary Electrical Appliances on Shipboard, issued by the Navy Department. This information will serve to indicate the nature of apparatus required and the tests to which it is subjected.

FORCED DRAFT BLOWERS.

The forced draft blowers are located in special compartments immediately above the fire rooms, these compartments being virtually an enlargement of the air ducts leading down from the weather deck. The blowers are of the double-inlet type, with inlet cones fitted with coarse wire mesh. The

wheels are of the multi-blade type, of especially rigid construction, and are mounted directly on the armature shaft. The fan is non-convertible, but is arranged for securing rigidly to the deck with downward discharge. The motor is supported on a separate bedplate and the shaft is provided with three bearings. Fan-wheels are carefully balanced and

The controller for forced draft fans is of the watertight contactor type, mounted in the same compartment with the blower. This controller is operated by a master controller, also of the watertight type, located in the fire-room. The master controller handles only the magnetizing current for the contactors and the field current for the motor. Complete

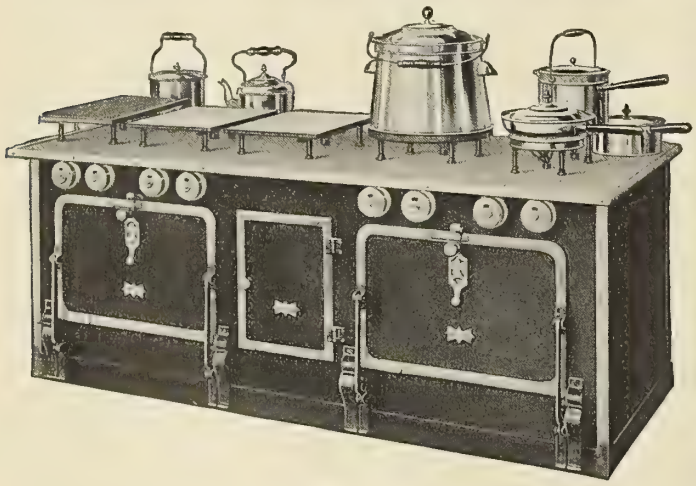


FORWARD DECK OF U. S. S. MISSISSIPPI, SHOWING ELECTRIC DECK WINCH.

are tested for strength to resist centrifugal strains by running for one-half hour at 25 percent above maximum rated speed.

Motor-driven forced draft fans are usually of about 25,000 cubic feet per minute capacity, and are required to maintain a static pressure in the fire-room of about 2½ inches of water.

The motor is of the completely enclosed watertight type, and must drive the fan at a maximum speed sufficient to deliver the rated volume of air against the pressure required to be maintained in the fire-rooms. The speed must be



ELECTRIC RANGE.

capable of being reduced 20 percent below maximum in at least ten steps. Each motor is required to pass an eight-hour shop test without overheating while driving its fan at full speed, and with the air delivery so restricted as to require an armature current not less than 25 percent in excess of that obtained on the efficiency tests. After installation the forced draft blowers are subjected to a 96-hour test.

control of the blower is afforded by the master controller in the fire-room, including starting, stopping, adjustment of speed and resetting the overload device. A small auxiliary master controller is mounted in the blower room, and may be used for starting and stopping the motor from that point. In addition to the overload device provision is made in the controller, so that in case the air leakage from the fire-room is excessive, imposing an overload on the motor, the shunt field rheostat will be automatically cut out, reducing the motor speed to minimum, thereby preventing the fan from overloading the motor. This provision permits of smaller motors being used than would otherwise be possible. Twenty-five thousand cubic feet blowers are usually equipped with motors of about 25 horsepower.

ELECTRIC STEERING GEAR.

The electric steering gear proposed for use on recent vessels consists of a rudder motor connected to the rudder stock through suitable gearing and an automatic contactor controller arranged for distance control by means of master controllers located at the different steering stations. The master controller handles only the small magnetizing current for the contactor solenoids, so that only a few wires of small capacity are required between the master controller and the automatic contact controller. The latter is located in the same compartment with the motor, and handles the heavy armature current. A magnetic disc brake is mounted on the armature shaft to bring the rudder to rest promptly in the desired position.

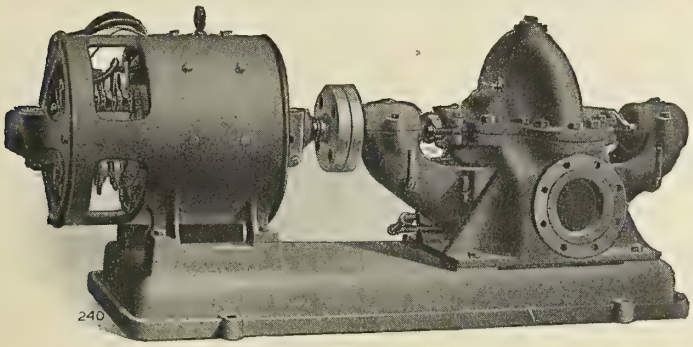
In certain cases where the electric steering gear has been installed in conjunction with an existing steam steering gear, the master controller for the electric gear has been located close to the steam valve of the steering engine, and has been operated by the existing mechanical connection between the steering station and the steering engine. In the latter case it is customary to arrange the master controller so that a move-

ment of the rudder turns the controller towards the "off" position. This results in a follow-up feature, which automatically brings the rudder to rest at the angle represented by the position in which the steering wheel is left at the steering station.

The electric gear is equipped with automatic stops in the "hard-over" position of the rudder, which automatically cut off power from the motor and bring the rudder to rest, but which do not prevent the rudder from being returned towards the central position. An automatic overload device is installed, which does not entirely cut off the current from the motor, but which inserts resistances in the armature circuit and reduces the speed, thereby protecting the motor and at the same time leaving the helmsman in control of the rudder.

The motor is of the open type, compound wound, and rated for continuous duty. The necessity for uninterrupted service and the nature of the duty requires a motor of a very rugged character. The horsepower of the motor is proportioned in accordance with the speed and dimensions of the vessel. The standard requirements for steering gears is that they be capable of putting the rudder from "hard over" to "hard over" in twenty seconds with the vessel going full speed ahead. The motor is required to stand a shop test at full load for eight hours without overheating, also an overload of 100 percent for one-half hour without damage or objectionable sparking. The electric steering gear is tested after installation by turning the rudder from "hard over" to "hard over" for a continuous period of four hours at full speed with the vessel afloat and at rest.

The contactor controller is of the non-watertight type, and, together with the rheostats, is mounted convenient to the motor. The master controller is usually of the enclosed drum type. The contactor controller is of the switchboard type, with the starting, reversing and braking contactors, together with the series relays and overload coils, mounted on the front. The reversing contactors are mechanically interlocked so that it is impossible for both sets to close at one time. The rapidity of acceleration is automatically governed by series relays, so that the operation of the gear is independent of the helmsman after he has made the initial move-

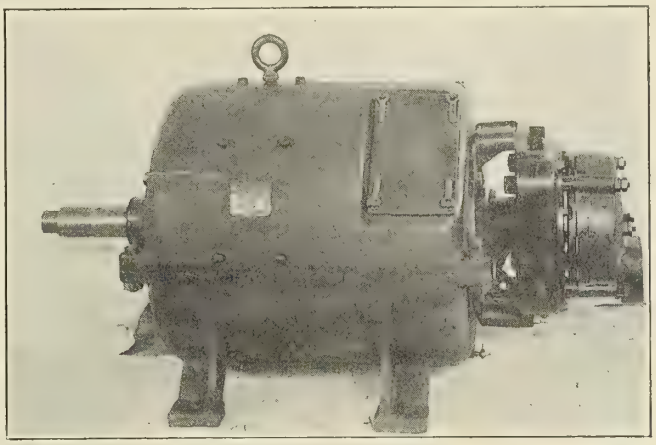


DIEHL MOTOR WITH CENTRIFUGAL PUMP.

ment of the steering wheel or lever. The overload device, limit switch relays, etc., are reset automatically, so that the helmsman has complete control of the gear at all times when the circuit is energized, without local attendance. This system of electric steering gear gives prompt and rapid movement of the helm to the desired angle, and has sufficient delicacy to respond to movements as small as 2½ degrees.

MOTORS FOR TURNING OVER MAIN ENGINES OR TURBINES.

Certain vessels are equipped with motors for turning over the propelling engines or turbines. These are arranged to engage the main shaft through suitable gearing for the purpose of rotating the same slowly and stopping at any desired point for inspection or repairs. These motors are compound wound, watertight, reversible, and with a speed adjustment of not less than 2 to 1. Each motor must stand a shop test at full load for thirty minutes without overheating. The shunt field must stand full excitation for eight hours without overheating. The motor must also stand 100 percent overload for one minute at both maximum and minimum speeds without injury or unsatisfactory commutation. Motors of about 5-horsepower capacity are used for this purpose. The controller is of the self-contained, reversible, watertight, drum type, and provides the necessary speed variation. After installation this apparatus is tested by driving the main engines



DIEHL DISC BRAKE MOTOR.

or turbines at the maximum required motor speed continuously for a period of fifteen minutes in each direction.

POWER-OPERATED DOORS AND HATCHES.

Power-operated doors have been extensively used for preserving the watertightness of important bulkheads in naval vessels where it has been considered necessary to provide access doors in the bulkheads of the machinery spaces and other important compartments. Power gear has also been applied to certain important hatches. The power for this purpose was originally hydraulic and pneumatic, but these soon gave way to the electric gear.

The style of door generally used for power operation consists of a rigid casting secured to the bulkhead around the free opening, which is provided with a machined contact surface and which is expected to make a practically watertight contact with the corresponding machined surface on the door. The door is virtually a metal gate which slides vertically or horizontally in guides on the door frames, and which forces itself against the door seat in the closed position by engaging with wedges on the door frame.

The following methods have been used for operating sliding doors:

(*a*) A screw driven by a motor attached to the bulkhead engages a nut secured to the door. On certain vertical sliding doors of this type the nut was secured to the door by a latch which could be knocked out, allowing the door to fall and seat itself by gravity. Horizontal doors of this type were operated by two screws, one at the top and one at the bottom, to prevent the door from tilting and becoming wedged.

(*b*) The door carries one or two racks which are engaged by corresponding pinions, driven by a motor attached to the door frame.

(*c*) The door carries one or two worm racks which are engaged by corresponding worms, driven by a motor attached to the door frame.

(*d*) The door carries one or two pin racks which are engaged by corresponding sprocket gears, driven by a motor attached to the door frame.

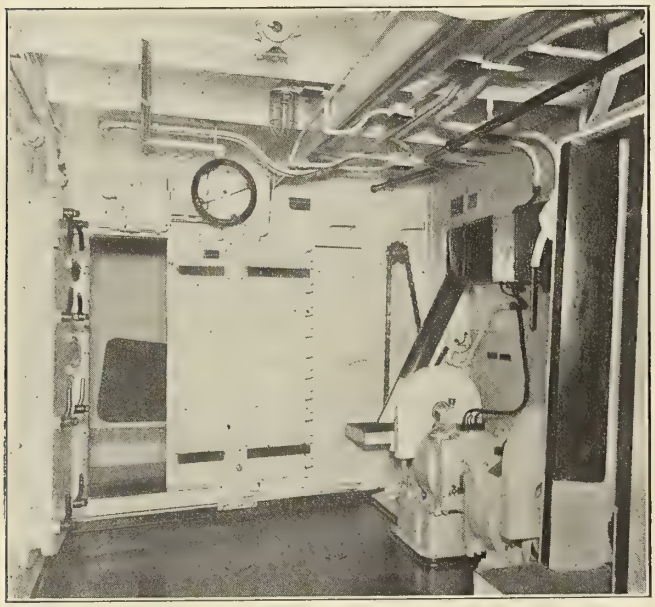
The latter arrangement is more satisfactory, as it permits of considerable freedom of movement of the door without interference with the driving sprocket.

The power hatch covers are hinged at one side, and are raised and lowered by a system of levers, operated by a motor mounted beneath the deck.

A small controller mounted in a watertight metal box, and operated by an external lever, is mounted at each door at a convenient height, and the shaft is extended through the bulkhead for operation from either side. Provision is also made by suitable gearing at either side for the attachment of a portable hand-wheel, so that the door may be operated by hand in case the power gear fails.

All the power doors and hatches in the ship can be closed from an emergency station located in the pilot-house, but the doors may be opened by the local controller, either during or after the emergency closing from the power house. As soon as the local controller is released, however, the emergency closing will again take place.

The screw-operated door is provided with an adjustable



HORIZONTAL ELECTRICALLY OPERATED DOOR.

traveling nut in the motor frame, which automatically cuts off the power when the door reaches the extreme open or closed position.

The rack and pinion door has a plunger-operated switch, which is engaged by the door in the extreme open and closed positions and which cuts off the power. A later type of rack and pinion door is equipped with a rheostat in the armature circuit and with specially wound motors, so that the power is not cut off but the motor continues to exert torque after being stalled as long as the controller is held in the running position. When operated from the emergency station the doors of this system close in groups of six motors in series, the resistance of the circuit being sufficient to limit the current to a safe amount after all the motors are stalled.

The doors, which are operated by the worm and worm rack, also by the pin rack and sprocket gear, are so arranged that the thrust of the gear against the door acts against a calibrated spring, the compression of which cuts off the power. These doors cut off at a predetermined pressure instead of at a predetermined position, and if stalled by an obstruction will again take power and continue to close after the obstruction is removed, provided the emergency switch remains closed.

The emergency station consists of a series of illuminated dials, one for each door, which light up and indicate when the door is closed; also the necessary switches or push buttons for controlling the automatic solenoid closing switches at the various doors.

The motors are about 1 horsepower, series wound, about 1,000 revolutions per minute, and of the watertight type. They are required to carry full load on shop test for one-half hour without overheating, also 50 percent overload for five minutes without injury or unsatisfactory commutation, and stalling at full voltage for ten seconds without injury. If the system of control is such as to require stalling of the motors with current in the armature they are also tested in the shop by stalling under shipboard conditions until a constant temperature has been reached on all parts. This temperature must not exceed 100 degrees C. with a room temperature as high as 40 degrees C.

All of the electrical apparatus, wiring and gearing of power doors and hatches is maintained watertight, and on the later vessels this apparatus is mounted very compactly upon a bridge extending across the top of the door frame.

The tendency towards integral watertight bulkheads without communication between the various compartments, except by going up to a deck above the waterline, has led to the abandonment of power doors on the latest vessels.

CENTRIFUGAL VENTILATING FANS.

Warships are equipped with very complete facilities for ventilation, consisting of systems of metallic ducts extending throughout the vessels below decks, each of which system is equipped with a direct-connected, motor-driven centrifugal fan, which draws its supply from the outside air and discharges into the distribution ducts. Certain spaces, such as lavatories, etc., are ventilated on the exhaust system. The aggregate capacity of the ventilating sets on large battleships is about 250,000 cubic feet per minute. The fans vary in size from 600 to 12,000 cubic feet per minute each, and the motors from ½ to 10 horsepower.

The fans are convertible for either right or left-hand and different angles of discharge, and in the small sizes are so constructed that they may be installed on deck, on the vertical bulkhead, or suspended from the deck above. The fans are of the single-inlet type, and the tendency on recent vessels has been towards the high-speed multi-vane type of fan-wheels, resulting in reduced diameter of fan casings. For general ventilation purposes the fans are required to deliver their rated volume of air into the duct at a velocity of 2,000 fet per minute against a static pressure of about 9½ pounds per square foot, assuming atmospheric pressure at the intake. Special fans for supplying turrets, and also for forcing air through coolers to refrigerated spaces, are required to deliver air against pressures in excess of that above stated. Heaters are arranged in connection with the ventilating ducts to living spaces, so that in cold weather warm air may be delivered to these quarters.

The motors are shunt wound and of proper speed to operate their respective fans at full duty. The motors are required to have sufficient speed reduction by field control to enable them to operate the fans continuously at minimum speed and with the fan inlet and outlet wide open without overheating. The fans are tested for delivery and efficiency in the shop, the air readings being obtained in improvised ducts by means of Pitot tubes. Fans are required to show a mechanical efficiency of 50 percent when operating under the above prescribed load, also the efficiency of the set; that is, motor and fan combined is required to be not less than 31 percent for the smallest set, increasing up to 40 percent for the largest. Motors are required to drive their fans at full speed, with the air delivery so restricted as to require an armature current not less than 25 percent in excess of that obtained on the efficiency test for eight hours without overheating.

These sets are operated continuously night and day, and extra precaution is taken to insure that their operation will be satisfactory over long periods.

PORTABLE VENTILATING FANS.

For the purpose of supplying special temporary ventilation to spaces on shipboard which are not regularly supplied by the ship's ventilation systems, small portable ventilating sets are supplied. Each set consists of a centrifugal blower, with discharge orifice not less than 4⅜ inches in diameter, and with bottom horizontal discharge direct connected to a series wound enclosed motor with ball bearings.

The set is required to deliver not less than 425 cubic feet of air per minute through a straight cylindrical tube 36 inches long, 4⅜ inches in diameter, which is equivalent to a velocity of about 4,100 feet per minute. With the motor warm the electrical input at this air delivery must not exceed 185 watts. The motor is required to drive the fan at full speed with inlet and outlet wide open for four hours without overheating. The weight of the complete set must not exceed 50 pounds.

DESK FANS.

Desk fans for use on shipboard are of two sizes, 12 inches and 16 inches in diameter over the blades. The 12-inch fans complete must not weigh more than 20 pounds, and must have a velocity of air discharge of not less than 1,500 feet per minute at not to exceed 56 watts electrical input. The 16-inch fan must weigh complete not more than 30 pounds, and have a velocity of air discharge of not less than 1,800 feet per minute at not to exceed 90 watts electrical input. The fans are designed for satisfactory operation on 80 or 123 volts direct current. Reduced air deliveries are permitted when operating at 80 volts. The fans are suitable for mounting on a vertical or horizontal surface, and the axis of revolution is adjustable 120 degrees horizontally, and vertically from horizontal to 40 degrees below horizontal. A continuous-duty regulating rheostat is mounted in the base, which gives three speeds in the ratio of ½, ¾ and 1.

WORKSHOP MACHINE TOOLS.

A machine shop for a large vessel usually requires approximately the following motor-driven machine tools: Sixteen-inch sensitive drill, 28-inch upright drill, shaper, 14-inch by 5-inch lathe, 14-inch by 7-inch lathe, milling machine, gap lathe, boring bar, emery grinder, forge.

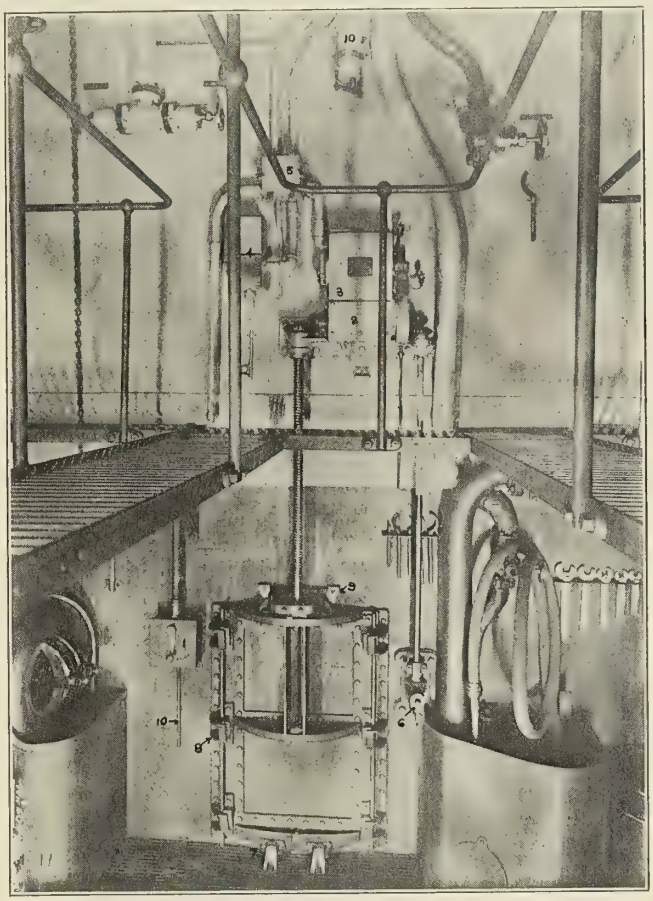
The assembled tools are required to be as compact as possible, with the controlling appliances arranged for the convenience of the operator. This is necessary on account of the limited space available for the installation of the tools. The characteristics of the motors are specified by the tool manufacturers. The motors are required to operate their machines at maximum capacity and speed without being overloaded. Preference is given to semi-enclosed shunt-wound motors.

Each motor is required to stand a full-load shop test for two hours without overheating. Shunt fields are tested at full excitation for eight hours. Motors must stand 50 percent overload for five minutes without injury and without unsatisfactory commutation at both minimum and maximum speeds.

Non-watertight controlling appliances are used. Panel-type controllers are used for small motors, but preference is given to self-contained drum-type controllers where frequent starting and regulating is required. The machine-tool motors range in capacity from ½ to about 7½ horsepower.

FRESH WATER, SANITARY AND DRAINAGE PUMPS.

The fresh-water pumps are of the single-acting triplex type, and are required to pump 60 gallons per minute against a head which is equivalent to about 50 feet. Fresh water is pumped from supply tanks in the hold to the gravity tanks, which are located sufficiently high to insure fresh water supply to the various spaces where needed. These pumps are usually located in a pump room above the supply tanks. The motor is of the enclosed type, 3 horsepower, about 1,000 revolutions per minute, and is direct connected to the pump by spur gearing. The controlling panel is of the enclosed watertight type, and is located in the same compartment with the pump. The sanitary pumps are of centrifugal type, and



VERTICAL SCREW ELECTRICALLY OPERATED WATERTIGHT DOOR.

on recent vessels have a capacity of about 500 gallons per minute each against a head quivalent to 40 to 50 feet. The pumps are direct connected to the motors. The motor used for this size of pump is of the enclosed type, 12 horsepower, about 1,150 revolutions per minute. The controller for starting duty is of the enclosed drum type, with separate rheostats. The rheostat is mounted in a frame behind a panel, upon the face of which is mounted the line switch, fuses and circuit breaker. In certain cases the circuit breaker has been superseded by a contactor, which acts in conjunction with the drum controller in the same manner as previously described under boat cranes and deck winches.

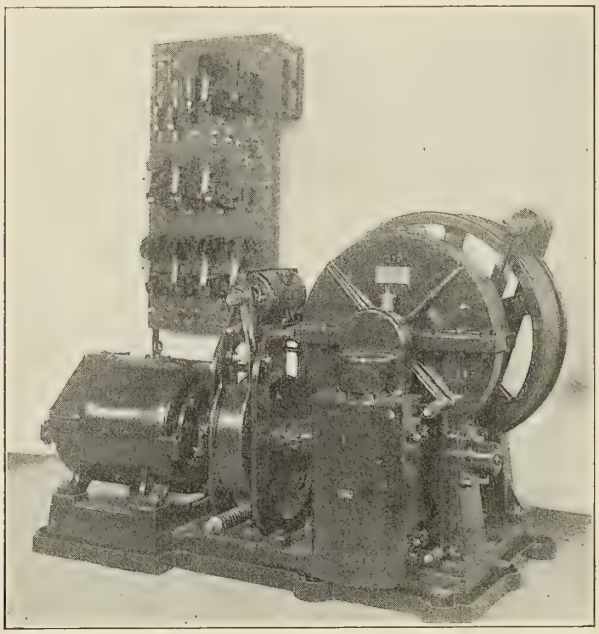
Pump motors are required to be compound wound to prevent objectionable increase in speed as the motors become warm in service. Each motor is required to carry full load for eight hours on shop test without overheating, also an overload of 50 percent for one hour without injury or unsatisfactory commutation.

DECK WINCHES.

The deck winches are located on the forecastle, quarter-deck and upper or boat deck, and are used for handling boats, coal and stores. Two kinds of winches are used—single geared and double geared. The single-geared winches have a capacity of 4,000 pounds at 200 feet per minute, and the

double-geared winches a capacity of 4,000 pounds at 200 feet per minute, also 16,000 pounds at 50 feet per minute. The double-geared winches are used on the forecastle and quarter-deck for handling anchors, shore lines and other heavy duty.

Each winch consists of a bed plate, upon which are mounted the motor, controller, rheostats, gearing and bearings for gypsy shaft. Two gypsy heads, 18 inches in diameter by 20 inches long, are carried by each winch. A foot-operated band brake is attached to the armature shaft in a convenient location for the operator, who handles the controller with one foot on the brake lever. The double geared winch is provided with a



ELECTRIC ELEVATOR MACHINERY.

hand-wheel for shifting from single to double gear, or vice versa. The gearing is entirely enclosed.

The motor, controller and rheostat are of the enclosed watertight type. The motor is compound wound—300-400 revolutions per minute—with split frame. The shunt field winding is only sufficient to limit the motor speed to a safe value when running light. On shop tests the no-load speed of the motor must not exceed the overload speed by over 100 percent. Each motor is required to carry full load for one hour without overheating, also 100 percent overload for one minute without injury and without unsatisfactory commutation. The shunt fields are required to carry full current continuously for eight hours without overheating. The controller is of the drum type with about five speeds. Reversal is effected by a separate lever, which is interlocked with the controller shaft, so that the motor can only be reversed with the controller in the "off" position. A separate reversing lever is provided, so that when starting up with a suspended load on the winch it will not be started carelessly in the wrong direction, which might result in damage. The earlier types of controller had a circuit breaker mounted in the controller casing and operated by external levers. More recent controllers have a contactor substituted for the circuit breaker. This contactor will pick up on the first controller position, and is provided with an overload trip coil. It therefore serves the purpose of a line switch, overload and no-voltage release, and also interrupts the circuit at the contactor instead of at the controller contacts, thereby increasing the life of the latter indefinitely. It is necessary to return the controller to the "off" position to reset the overload device. No external levers are required except the controller lever and reversing lever. The rheostat is of the cast grid type, mounted in a watertight metal case. The leads are brought up through deck stuffing tubes into the winch base, and the wires between the motor, controller and rheostat are either run through a recess in the base or through conduit, making a watertight entrance into each fitting.

CAPSTANS.

The capstans proposed for recent vessels consist of a vertical gypsy head mounted above the weather deck and driven by a vertical spindle from the deck beneath. The capstan motor drives, through a suitable spur gearing reduction, to the worm and worm gear mounted on the lower end of the vertical spindle. The capstan is double geared for slow and fast speeds, and is capable of hoisting a load of 4,000 pounds at 200 feet per minute, or 16,000 pounds at 50 feet per minute. The motor is the same as that above supplied for the deck winches, except that it is of the open type. The motor is equipped with a magnetic disc brake which will set and hold the shaft in case the voltage at the armature fails from any cause. The controlling panel and rheostat are mounted in the same compartment with the capstan machinery. The control panel is of the automatic contactor type, controlled by a small drum type master controller, which latter is handled by the operator on deck beside the gypsy head. The master controller provides about five speeds in each direction, and also affords suitable restraining control on the first notch in each direction for paying out line under strain. The master controller is of a very rugged waterproof type, to withstand service on the weather deck; the remainder of the apparatus is on the deck beneath, and is of non-watertight type.

ELEVATORS.

Certain recent naval vessels have been equipped with electric passenger elevators for access to the fire rooms from the gun deck. The height of the lift from the landing platform in the fire rooms to the gun deck is about 15 feet, and the cage is required to travel at such a speed that not more than fifteen seconds will intervene between levels. The main air ducts for supplying air to the fire rooms are used for these elevators, and the cages are of skeleton construction, so as to offer as little resistance as possible to the downward passage of the air. The control is entirely automatic, the motor controller and winding machinery being mounted in a special compartment on the berth deck.

The elevator is controlled by three push buttons in the cage, two at the upper and one at the lower level. Special safety appliances are installed to prevent accidents.

The working load of the cage is 500 pounds. For balanced elevators, motors of about 4 horsepower are used, and for unbalanced elevators 7½-horsepower motors are used. Motors are usually compound wound, the series field being used only in starting, after which it is cut out. Each motor is required to carry full load for one hour without overheating, and 100 percent overload for one minute without damage or unsatisfactory commutation. Shunt field must carry the current, which will be obtained in service for eight hours without overheating. The controllers are of the contactor type, the operating circuits of which are controlled by the push buttons and by the automatic stops at the winding drum and in the trunk. All electric fittings in the cage and trunk are of the watertight type. The motors and controllers, which are located in the special compartment on the berth deck, are of the non-watertight type. Three or four elevators are installed in a single vessel.

LAUNDRY.

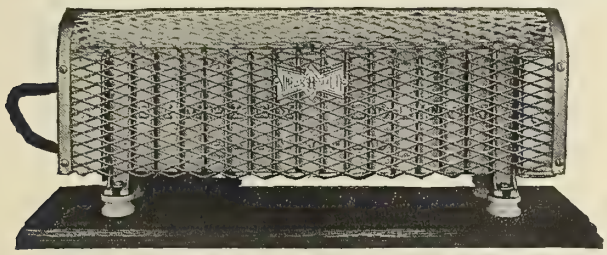
Laundry outfit consists of the following: Power-driven washer, power-driven centrifugal extractor, power-driven

electrically-heated combination ironer, power-driven electrically-heated band ironer, power-driven electrically- heated reverse body ironer, wash tubs, soap tanks, starch kettle, ironing table and drying room. The laundry machinery is belt-driven from overhead shafting, power being furnished by a 6-horsepower motor which, with its controller, is mounted in the laundry compartment. The motor is shunt wound, constant speed, about 850 revolutions per minute, of enclosed watertight type. The controller is of the panel type, completely enclosed in a watertight case, together with the rheostat, and is operated by external levers.

Experiments have recently been conducted with individual motor drive for the different laundry machines upon certain vessels, and it is believed that this arrangement is superior to the belt drive from overhead shafting and will eventually be used.

ELECTRIC RANGES AND BAKE OVENS.

The substitution of oil for coal as fuel on recent battleships, together with the greater cleanliness and utility of electric cooking devices as compared with coal ranges and ovens, has led to the adoption of the former almost exclu-



SIMPLEX ELECTRIC STATEROOM HEATER.

sively for vessels carrying a sufficient electric plant for supplying the same.

The standard electric range is provided with eight stove plates on top, with two broiler chambers immediately beneath and two ovens at the bottom. The broilers and ovens open at the front. The stove plate contains the heating element sealed in an inner recess. These plates are detachable, and are arranged to align with current carrying clips when the plate is inserted in place. Each broiler has one heating unit at the top; each oven has two heating units—one at the top and one at the bottom. The heating unit for the oven slides into a recess separate from the oven chamber, so that it is protected from damage and from contamination by spilled food.

The electric bake oven is furnished in two sizes, the larger containing three double baking compartments and the smaller two compartments. The arrangement of heater units is the same as that for the oven compartments in the range. The electric bake oven, however, is devoted entirely to the baking of bread, and is not provided with as great heating facilities as the range oven, which latter is used for roasting meat.

The amount of food to be handled and the rapidity with which it must be prepared make it necessary that the electric ranges and bake ovens be equipped with powerful heaters. Each baking chamber must be capable of maintaining a baking temperature of 500 degrees F. The hot plates are required to maintain a temperature of not less than 750 degrees F. at the center, and the broiler unit, which is of the radiant heat type, must operate satisfactorily at a bright red heat. The bake oven will reach a temperature of 500 degrees F. in from forty to fifty minutes, starting cold. The oven of the range will reach a temperature of 500 degrees F. in about twenty-five minutes, starting cold. The stove plates will reach a temperature of 750 degrees F. in about twenty-five minutes, starting cold. The broiler assumes a red heat almost immediately after the current is turned on. To accomplish the foregoing each range requires about 30,000 watts, or about 40 electrical horsepower, when all parts are in operation simultaneously on high heat. Under the same conditions each large bake oven requires about 16,000 watts, or 21 1/3 electrical horsepower.

The resistance material is required to be of metal having a specific resistance of not less than 570 ohms per mill foot at 75 degrees F., and a melting point of not less than 2,200 degrees F., and must be capable of running continuously at a temperature of 1,350 degrees F. without detrimental oxidation.

MARINE ELECTRIC GENERATING PLANTS, DISTRIBUTION AND INTERIOR COMMUNICATION SYSTEMS.

BY W. Y. AVERY.

DYNAMO ROOMS.

On destroyers, colliers and smaller vessels the generating sets with switchboards and accessories are installed in the engine rooms, following the usual practice on commercial vessels. In the case of battleships two 300-kilowatt generating sets are located in each of two dynamo rooms, connected by a ventilated wiring passage, all located below the protective deck. The generator panels are located one in each dynamo room, while distribution boards, all interconnecting, control switches, etc., for each set of dynamos in the distribution room nearby. This is a separate watertight compartment with access separate from the dynamo room.

Generators in each dynamo room exhaust into a separate auxiliary condenser located in a compartment directly under the dynamo room. This allows the large exhaust pipes required for turbines to be led directly down, ensuring a neat appearance and efficient drainage. The steam for generating sets is supplied from the main auxiliary line, so arranged that steam may be obtained from any boiler or combination of boilers. The valves on both steam and exhaust pipes are fitted to enable one set to be overhauled while the other set in the dynamo room is running.

In each dynamo room there are fitted wrench boards, work bench, bulletin and instructions boards, lockers for tools and supplies, a log desk, oil sets, waste pockets, etc., also a tap to ship's compressed air system for attaching a hose for cleaning armatures.

The dynamo rooms are ventilated by electric fans, supplying air and natural exhaust via trunks leading to open deck. Trunks are of sufficient size to permit largest part of generating sets being struck down. The ventilating fans are of sufficient capacity to make a complete change of air in dynamo room once every minute. The capacity of generating sets is approximately one-half the rated power of entire electric plant requirements.

GENERATING SETS.

The greater number of vessels are fitted with generating sets of reciprocating engine type, a few of the later vessels being fitted with turbo-generating sets. Generating sets with reciprocating engines were used exclusively to about 1908. They usually consist of an engine direct connected to a 125-volt direct-connected generator, with the engine designed for 100 or 150 pounds steam pressure, as specified, and 25 inches vacuum. Sizes 8 kilowatts and below have simple and larger sizes compound engines.

Previous specifications in the United States navy required engines to run without oil in the cylinders; tests demonstrated, however, that considerable oil was drawn into the cylinders from the piston rods. To overcome this the sets on

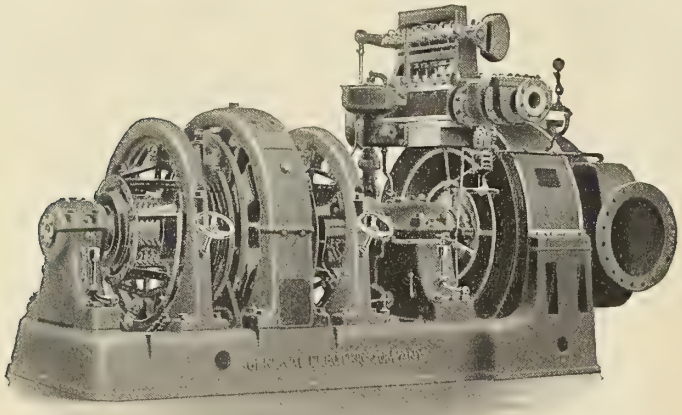
all ships with watertube boilers were changed, by rising cylinders, so that a part of the piston rod did not enter either the cylinder stuffing-box or the gland in the guard over the enclosed crank pit.

In addition to the raised cylinders present specifications require cylinders for larger sets to be fitted with removable linings.

The standard sizes, with their corresponding maximum allowable speeds, weights and over-all dimensions, are:

Size in Kilowatts.	Revolutions per Minute.	Weight in Pounds.	Length in Inches.	Width in Inches.	Height in Inches.	Dip of Magnet Frame.
2.5	800	500	32	20	34	..
5	750	1,000	50	28	43	..
8	550	2,700	64	34	56	..
16	450	5,600	78	40	65	..
24	400	7,300	88	48	78	..
32	400	10,000	101	53	85	1¼
50	400	13,000	110	60	87	2
100	350	22,000	125	70	106	1

The normal steam pressure under which the engine, running condensing with 25-inch vacuum for different size sets,



6-POLE, 300-K.W., 1,500-R. P. M., 125-VOLT GENERATOR DRIVEN BY A CURTIS TURBINE.

operate and the maximum allowable water consumption per kilowatt-hour output of the set are:

Kilowatts.	Normal Steam Pressure.	Water Consumption per Kilowatt Hour, Full Load.
2.5	100	105
5	100	90
8	100	70
16	100	44
24	100	41
32	100	39
50	150	35
100	150	31

This type of generating set has proved reliable and efficient.

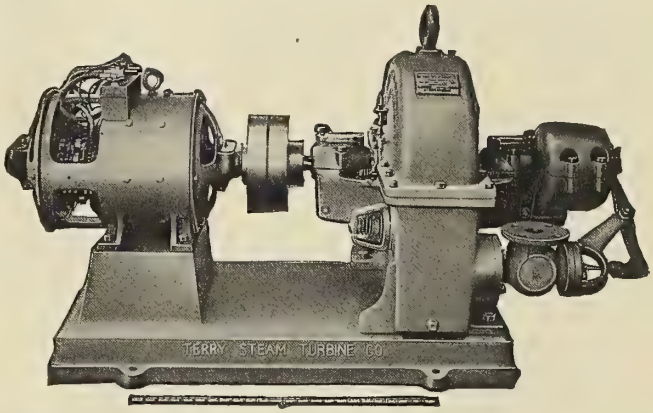
TURBO-GENERATING SETS.

Manufacturers of turbo-generating sets were encouraged to design small units, and a comparison with reciprocating engine generating sets indicated that turbo-sets would be free from oil in steam spaces, slightly lighter in weight, smaller in width and height, considerably longer, have a slightly greater water rate if a good vacuum was provided, and the speed would be greatly increased.

There are nine of the larger vessels in commission and nearing completion fitted with turbo-generating sets manufactured by the General Electric Company, and one vessel—the U. S. S. *Connecticut*, with the forward dynamo room only fitted with Terry-Diehl turbo-generating sets. The latest battleships have four 300-kilowatt generating sets, two in each dynamo room.

Turbo-generating sets manufactured by the General Electric Company have generators meeting requirements for reciprocating engine generating sets, direct connected to horizontal Curtis turbines. The governor is a mechanical type, which opens only a sufficient number of nozzles for load the set is carrying, and is accessible and efficient.

The 100-kilowatt generating sets on the U. S. S. *Connecticut*



7½-K.W. TERRY TURBINE GENERATING SET.

consist of Terry turbines, direct connected to generators manufactured by the Diehl Manufacturing Company. The governors are of the centrifugal type, throttling steam supply. These sets have operated satisfactorily and, due to the split frame, turbo parts are accessible and easily inspected or repaired.

Torpedo boat destroyers are supplied with 5-kilowatt turbo-generating sets. Those supplied by the General Electric Company are similar to the larger types, except the governors, which are of the centrifugal type, throttling steam. Generators of this size of the Terry-Diehl type are installed on several destroyers.

There are several emergency safety contrivances required, including a pop safety valve to prevent injurious back pressure due to a leaky throttle valve; an emergency valve and generator for automatically closing down when speed increases from 7 to 10 percent above normal. In addition, the exhaust pipe is so arranged that in case of failure of condenser the set automatically exhausts direct to atmosphere against a spring valve set at 5 pounds.

Generating sets of 100-kilowatt capacity and larger are provided with a coupling between armature and turbo-wheels; and sets, 25 kilowatts and smaller, are now required to operate under full load with a back pressure of 20 pounds, in order that exhaust steam may be used for feed-water heating if desired.

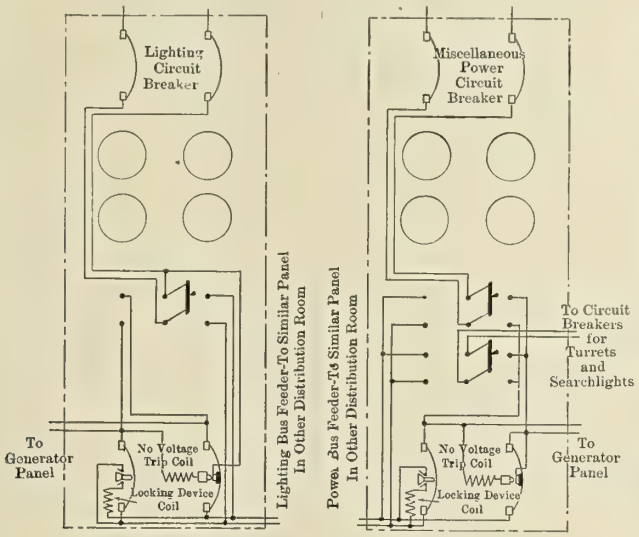
In the larger vessels the general arrangement follows shore practice, with the installation of condenser, pumps, etc., in the compartment below dynamo room. In general, the turbos are giving excellent service. The compounding limits of 2½ volts is rather close for this type of set, but by careful adjustments is attained. These limits are necessary, due to large size (compared with capacity of generating sets) of several motors used for intermittent service, such as boat cranes, hoists, etc.

SWITCHBOARDS.

A generator panel arranged to control two 300-kilowat, direct-connected 125-volt units is installed in each dynamo room. Generator panels are arranged for each unit, starting at the top, with a single-pole, overload, time-limit circuit breaker; voltmeter, ammeter, field rheostat handle, switch to positive lighting bus, switch to positive power bus, switch to common negative bus, and switch to equalizer bus.

Bus feeder panels and distribution panels are located in both the forward and after distribution rooms. The distribution boards are energized by separate bus feeder connections for lighting and power. On battleships the power is divided into turret power and miscellaneous power circuits, and connections are such that either, or both, the forward or after boards may be energized from either dynamo room through bus feeder panels in both distribution rooms.

The circuit breaker at bottom of the power panel contains a locking device, which prevents closing when power bus between distribution rooms is energized, also a no-voltage re-


Lighting Circuit Breaker
To Generator Panel
No Voltage Trip Coil
Locking Device Coil
Lighting Bus Feeder-To Similar Panel In Other Distribution Room
Fig. 1
LIGHT FEEDER PANEL
Miscellaneous Power Circuit Breaker
To Circuit Breakers for Turrets and Searchlights
To Generator Panel
No Voltage Trip Coil
Locking Device Coil
Power Bus Feeder-To Similar Panel In Other Distribution Room
Fig. 2
POWER FEEDER PANEL

DIAGRAMS OF SWITCHBOARD ARRANGEMENTS.

lease which opens circuit breakers upon failure of voltage in near dynamo room. The circuit breaker at bottom of lighting panel is precisely the same, except that the no-voltage release connection leads to center point of the double-throw lighting switch. This permits of a smaller circuit breaker, as only the load on near board can pass through circuit breaker. As there are two double-pole, double-throw power switches this advantage on power circuit is lost, and circuit breakers of capacity sufficient for full power of both boards are installed. These circuit breakers contain no overload coils.

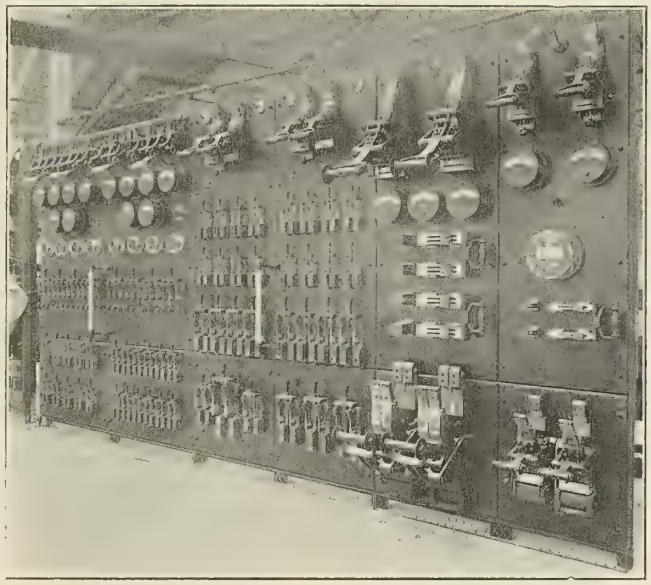
In general the switchboards follow best shore practice, but are necessarily more congested. Bus-bars are limited to ¼ inch in thickness, and clearance between parts of opposite polarity to 1¼ inches.

When facing the board the upper blades of all horizontal switches and the right-hand blades of all vertical switches are of positive polarity.

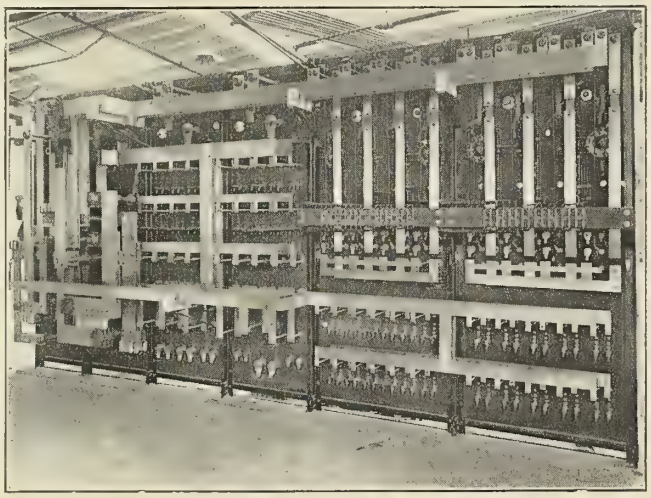
LIGHTING.

Lighting currents on war vessels are wired on the two-wire system, with a maximum allowable drop to most remote outlet of 2½ percent. The system consists of feeders leading from the nearest of the two main distribution boards, and from these feeders mains are led from fused junction boxes to various compartments. From branch junction boxes on mains, leads are taken, via group switches, to groups of lights connected in palallel, the limit being five lights on a fuse. No soldered joints are allowed, all connections being made by screws or clamps in fittings on porcelain bases installed in watertight boxes. In locations exposed to mechanical injury or the weather, wires are run in conduit; otherwise they are installed in open work, generally in split cleat or split porcelain insulators.

Carbon incandescent lamps have been used to date with a few recent exceptions, where drawn wire tungsten lamps have



FRONT VIEW OF FORWARD DISTRIBUTION BOARD OF U. S. S. ARKANSAS.



REAR VIEW OF ARKANSAS FORWARD SWITCHBOARD.

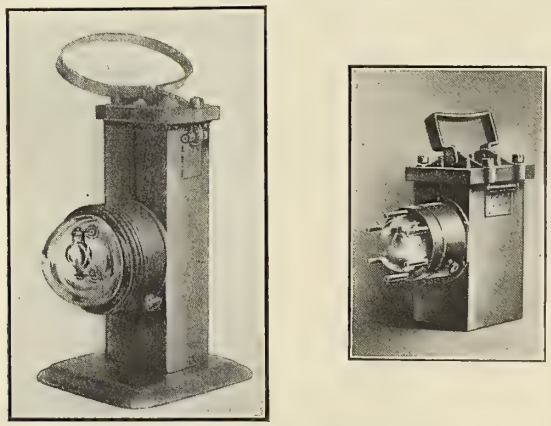
been installed and found to withstand service conditions in quarters and staterooms.

The modern battleships require about 2,700 fixtures, exclusive of two diving lanterns, three operating reflectors, running lights, screened speed, top, peak, boom and other special lights; also forty-two mercury vapor lamps, used for engine and fire rooms, machine shop and exposed deck lighting when coaling ship. As on shore, there is a demand for more brilliant illumination, which, due to the apparent success of the drawn-wire tungsten lamps, will probably be met by increasing the candle power and using this type of lamp in present fixtures. The mercury vapor lamps are manufactured by the Cooper-Hewitt Electric Company, and are of two types.

Single-tube, automatic-starting type, operating two in series on the 125-volt circuit, are used in general, and are permanently installed, with tubes fore and aft. For general deck lighting when coaling ship, etc., the double-tube, non-automatic-starting type is used. The effect of the general lighting, without deep shadows, has resulted in this type of lamp being preferred to the enclosed arc lamps previously supplied.

As a precaution against important stations being left in total darkness upon failure of generating sets, portable electric safety lanterns are provided. A battleship is supplied with twenty-four, located one in each dynamo and distribution room, in important passages, ammunition handling rooms, turrets, etc. They are also used for inspection of oil tanks and lighting of compartments when there is any possible danger of explosive gases.

Those now in use are made by the Portable Electric Safety Light Company, of Newark, N. J. The main feature of these lanterns is the alkaline storage battery with which it is equipped. The battery is not injured by an overcharge, reversal of charging current, or complete exhaustion. Long periods of idleness do not apparently affect its efficiency, and fumes given off when charging are not noticeable. The "navy



TWO TYPES OF HUBBELL ELECTRIC SAFETY LANTERNS.

type" contains a four-cell storage battery, energizing one of two 4-volt, miniature, tungsten anchor-filament incandescent lamps, the other being reserved as spare, and either may be used. Lanterns are capable of burning for twelve hours, and a fully-charged lantern after sixty days of idleness burns at least ten hours. They are well balanced, weigh 8½ pounds and are fitted with guards.

SEARCHLIGHTS.

The searchlights used for naval work are fitted with 36-inch parabolic lenses, and have a useful range of about 5,000 yards. Lamps are of an automatic feed, horizontal type, operating at 110 amperes and about 60 volts. Current supply is from the 125-volt circuits, and rheostats are used to cut down voltage. This arrangement appears wasteful of power, but as lights are required to burn but short periods it would not be economy to invest large sums in special generators or motor generators, transport additional weight and sacrifice space.

The searchlights are fitted with distant electrical control for both elevation and train; also distant mechanical control. The best results in picking up objects is obtained by placing operators at some distance below the searchlights.

The electric controller is attached to the end of a 100-foot armored cable and is portable. It is fitted with hand-wheels, which actuate a sight-bar on controller operating in synchronism with beam of light. This enables the battleship to remain dark with an equal chance of seeing the enemy first, and then pointing the lights prior to opening the shutters. The shutters are of the iris type, similar to those used on cameras, and are hand operated. In addition to these shutters there is provided a shutter which may be installed on any light and operated by hand for signaling. In addition to distant electrical and mechanical control each light is capable of being operated by hand locally.

INTERIOR COMMUNICATION.

The various interior communication systems on a modern battleship have developed to such an extent that their cost is more than that for both lighting and power systems combined. There are approximately 194 voice tubes; 250 thermostats of mercurial contact type in magazines, storerooms and bunkers; 58 12-inch general alarm gongs; 100 telephones, connected to a central switchboard for general ship's use; 7 telephones on a separate engine and fire-room circuit; 117 telephones on separate circuits for battle purposes (fire control); 38 howlers, with contact makers, used as signals for closing watertight doors throughout the vessel, also indicators on bridge showing which of the doors are closed; 25 10-inch gongs located at guns for cease-firing signals; salvo signals, consisting of 3-inch bells and portable buzzers at all guns to enable all guns of a caliber to be fired simultaneously, that gases and smoke of one gun will not interfere with the aiming of others, etc.

In addition to the electrical means of interior communication mechanical systems are installed as follows: Mechanical engine telegraphs with transmitters at stations forward, connected by brass wires and operating indicators in engine rooms; mechanical engine gongs in engine rooms; mechanical ammunition hoist signals in turrets; mechanical ammunition hoist gong signals for control of the amount and time of delivery of ammunition; anchor-handling gongs; jingle bells giving warning in ammunition handling rooms, and ash hoist gongs.

A battleship is supplied with duplicate motor generators for each of the following systems: Gun firing and sight lighting; interior communication; turret danger zone signals; turret tell-tale; telephone talking; telephone ringing, and also one special motor generator for warning signals for closing watertight doors. All motor generators, together with interior communication switchboard, are located in the interior communication room, which is a separate watertight compartment. The motor generators and starting panels are of open type. Motor generators are required for purposes involving the supply of current of a nature and voltage differing from that of the ship's distribution system, which is direct current, and unless otherwise specified 120 volts at power outlets.

The characteristics of the above motor generators are shown in the table which follows:

Purposes.	Generator Capacity.	Current Supplied.
Interior communication....	2 kilowatts.....	25 volts direct current, adjustable to 20 volts.
Turret danger zone signal, or gun firing and sight lighting.....	1½ kilowatts.....	125 volts alternating current, single phase, 60 cycles.
Telephone talking.....	Torpedo boat, 50 watt; battleship, 500 watt....	20 volts direct current, adjustable to 15 volts.
Telephone ringing.....	25 watts dynamotor.....	75–80 volts alternating current, single phase, 16⅔ 20 cycles.
Warning signals.....	As specified.....	As required for pole changer for operating "howlers."

TELEPHONES.

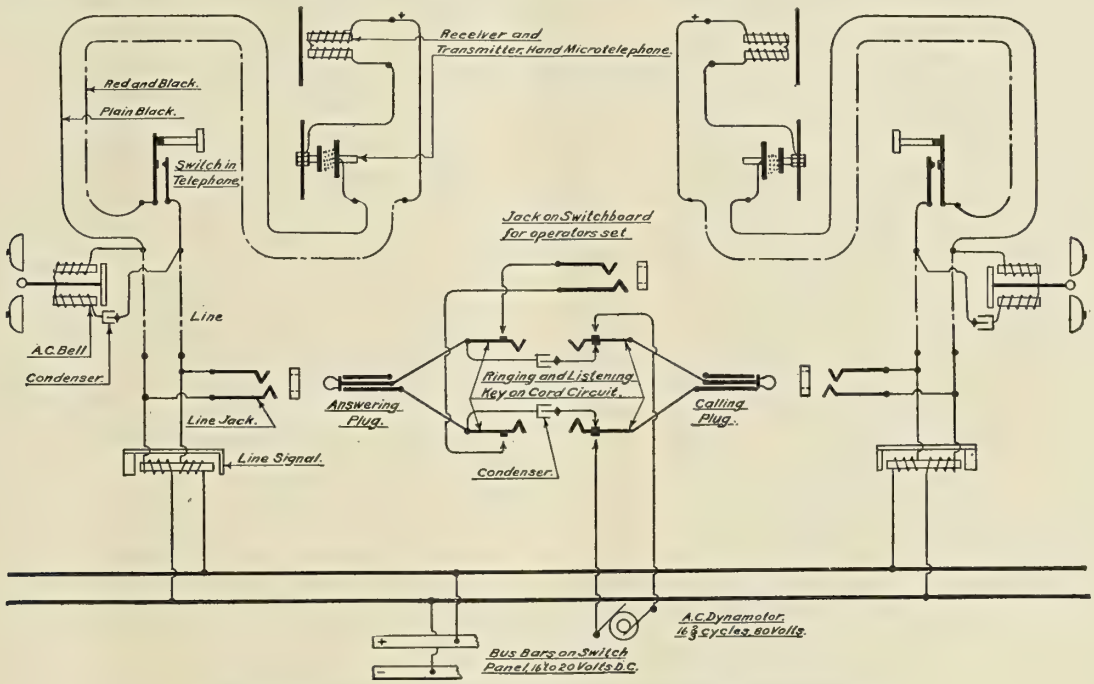
There are two distinct types of telephones on naval vessels—the low-resistance loud-speaking type and the present standard type, which is similar to the commercial high-re-

sistance type, except in mechanical features. Great difficulty has been experienced in maintaining the loud-speaking type in efficient condition, and the demands for fire control purposes, whereby as many as twenty-five telephones are at times connected on one line, and must be operated efficiently from one transmitter, have rendered the use of the loud-speaking type impossible. Commercial types were tried and found unsatisfactory, the principal reasons being that they could not be used in damp places and out in the weather, as cords were made up of tinsel conductor; terminals were exposed and transmitters and receivers were not made up watertight. These telephones were made up for long-distance service, and connections and accessories were more complicated than required for the short distances on shipboard. They were too sensitive for battle conditions, and would pick up extraneous noises to an extent that would render the system inoperative.

In the present navy standard telephones, the interior parts of receivers and transmitters of all types are the same and are interchangeable. The receiver is made watertight by the diaphragm being clamped against the rubber gasket in the cap by a threaded binding ring. The cores, permanent magnets, electro-magnets and terminal block are secured in a brass shell, which is threaded and screws into the cap until the shell comes against the binding ring, the thickness of which being such that the proper relations exist between face of electro-magnets and the diaphragm. The cap is secured to the case by five screws, a sheet gasket being used to secure watertightness. The cap, shell and case are each formed from one piece of tough sheet brass, and thus have the greatest possible strength for their weight. The transmitter consists of a movable electrode securely fastened to a diaphragm and a stationary electrode, the space between the two being loosely filled with very hard, shining granular carbon.

The telephone used for fire control circuits is a portable type, consisting of two receivers suspended on an adjustable webbing head gear, and is held against the ears by a spring located at the back of the neck. The transmitter is held on an adjustable breast plate. In general, this type of telephone has transmitters connected in series with the receivers in multiple. If, however, one officer is talking to an unusually large number of operators on one line his transmitter is connected in parallel across the line, which provides much loudrer talking in the receivers. Not more than one transmitter connected in parallel is permitted on any one line.

The telephone for regular ship service consists of a standard hand micro-telephone; *i. e.*, a navy standard watertight receiver and transmitter mounted on a handle and connected by a flexible cord to a holder for same, which contains the switch for cutting the instrument out of circuit when not in use. The hand micro-telephone type possesses several distinct advantages for shipboard use, such as equal convenience for persons of different heights; does not pick up noises, due to the operation of machinery, etc., as readily as does a telephone in which the transmitter is in metallic connection with the bulkhead. For signaling, a watertight, alternating-current, polarized bell is used, which is mounted entirely separate from the telephone. When telephones are installed in localities where they are subject to mechanical injury or the weather, they are installed in a watertight box, this box in special cases being mounted on a pedestal.



DIAGRAMS OF CONNECTIONS FOR SWITCHBOARD AND TELEPHONES FOR SHIP SERVICE.

SUBMARINE SIGNALING SET.

Submarines and their mother boats are fitted with submarine signaling sets for both sending and receiving; other vessels are fitted with receiving sets only. In principle the sending part consists of a submerged bell, struck at desired intervals by a hammer actuated by a spring, which is compressed and tripped by compressed air. The receiving part consists of special watertight telephone transmitters, one port and one starboard, each connected with a receiver. Its efficiency for locating direction depends upon the telephones being of equal sensitiveness. By listening with a receiver from port and starboard circuit at same time one will be louder than the other until ship heads directly toward the sending bell, when intensity of sound in each will be the same.

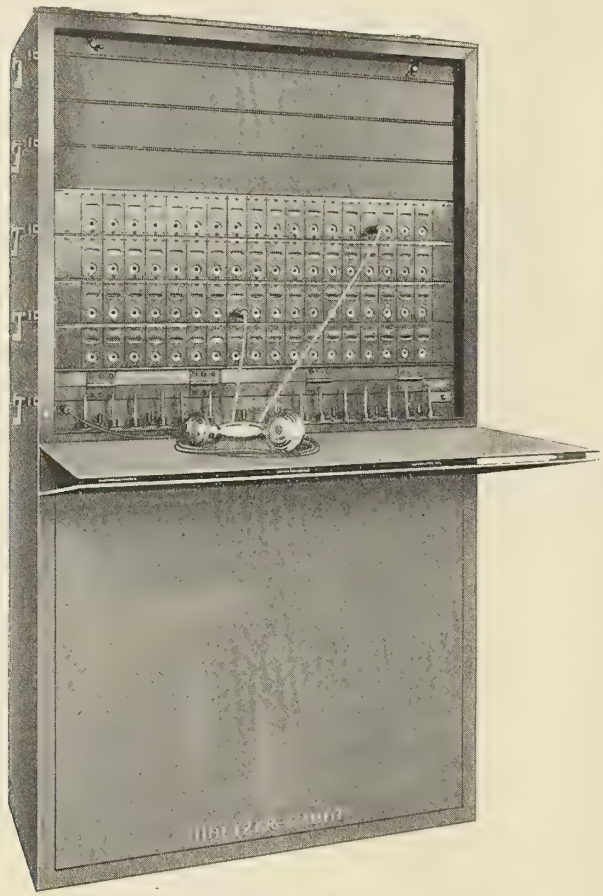
The transmitters are given the effect of being under water by suspending them in watertight boxes, one side of which is the skin of the ship, and filling the boxes with water. The location of these boxes depends upon the lines of the vessel. They are, however, as far forward as practicable without danger of picking up noise due to rush and hammer of water forward when under way.

The installation of buoys fitted with sending bells, striking code signals, is quite universal, and the receiving apparatus may be depended upon to 10 or 15 knots distance. The submarines communicating with each other are reliable up to about 3 knots.

CONDUCTORS.

The conductors are of soft annealed pure copper wire, evenly tinned. No strand exceeds No. 14 B. & S. gage. The rubber used contains from 39 to 44 percent, by weight, of fine unrecovered Para rubber, and is subjected to physical and chemical tests.

Lightning conductors are insulated by layers as follows: First, 1/64 inch thickness of unvulcanized rubber; second, vulcanized rubber; third, cotton tape thoroughly filled with rubber insulating compound; fourth, cotton thread braid saturated with waterproof compound.



TELEPHONE SWITCHBOARD.

Twin conductors are used to 60,000 c. m.

Bell wires consist of a single strand of No. 16 B. & S. gage wire, covered with a layer of vulcanized rubber and a close braid of impregnated cotton thread to 0.14 inch diameter.

Interior communication cable is made up in from three to thirty-six conductors, each consisting of seven No. 24 B. & S. gage wires, wrapped with cotton thread, covered with vulcanized rubber compound, then braided with cotton thread.

The required number is laid up with a twist, covered with cotton tape, vulcanized rubber and braid. One wire in each layer has a distinguishing color in braid.

WIRE WAYS AND WIRING ACCESSORIES.

Wooden molding is no longer used, due to the fire risk. Where a runway is required conduit is used. The conduit is of type galvanized on outside, either by electro-plating or dry process, and enameled on inside. Cast conduit fittings may be hot galvanized, and are enameled on the inside. Conduit is bent cold when installing, except when of size 1 inch I. P. S. and over with intricate bends, when it may be bent hot, in which case the inside is thoroughly coated with asphaltum. All conduit is of iron, also conduit fittings, such as elbows, nipples, etc., except in vicinity of compass, where brass is used.

In passages and where not exposed to mechanical injury or the weather, wires are installed in open work. A commercial type of split fiber or porcelain insulator is generally used. In some cases wires are led through bushed holes in plate hangers. The bushings consist of hard rubber nipples, threaded externally their entire length, and screwed in place in threaded holes in hangers.

Wiring accessories are of composition, consisting of from 65 percent to 88 percent copper, not more than 2 percent lead and the remaining percent of tin.

INSTALLING CONDUCTORS.

Wires are not pulled until the conduit is made up complete. Conduit fittings, with right and left threads, are not permitted, unions being required at intervals sufficient for removal of sections of conduit. When conduit leads are long, pullying sleeves are installed. Single lights and groups, to a maximum of five lights, are wired with 4,107 c. m. twin conductor, which size may be installed in ½-inch I. P. S.

The wiring is designed for maximum drop of 2½ percent for lighting circuits and 5 percent for power circuits, reckoned from bus-bars on generating sets. For lighting and continuous-power circuits 1,000 c. m. per ampere is required; for intermittent-power circuits 500 c. m. per ampere, provided drop comes within limits.

To prevent disturbing effect of current in leads in vicinity of magnetic compasses, wires of power and lighting circuits, located within 10 feet of standard and check compasses and 6 feet of battle and auxiliary compasses, have positive and negative leads twisted in even, close convolutions.

When necessary that power and lighting leads be installed in magazine spares they are led in porcelain insulators in groups, and covered with a watertight casing. Generator bus leads are calculated at 1,500 c. m. per ampere and equalizer leads one-half this size.

Electric Drive in Shipyards.

The advantages of electrical driving in shipyards are well understood, and it would appear to be only a question of time before it is taken up by shipbuilding firms on a much larger scale than at present. Two practical electrical systems are open for choice, either of which will give good results—these are the polyphase and the continuous-current systems. A three-phase generator, complete with exciter, will cost from 10 to 15 percent more than a continuous-current generator of the same output and speed, while the motors for a three-phase system will cost about 10 percent less than continuous-current motors. As regards the wiring, the total cost for this, including switches, would be about 5 to 10 percent less with a three-phase system; therefore the advantage is usually on the side of the three-phase system.

The simplicity of construction and robustness of the design of three-phase machinery and its adaptability to the requirements of a shipyard make it usually preferred. A choice of system should be determined by the proximity of a power supply company to provide for repairs being carried out without the need of a duplicate plant.

The cost of generating electrical energy is important. If there is an abundant supply of cheap coal and no difficulties with regard to water supply, the total cost per unit, with one or two generators of, say, 200-kilowatt capacity each, will be about 5/8d. (1¼ cents). Allowing for capital outlay, interest

and depreciation, cost of fuel, etc., under many conditions the cost would be about ½d. (1 cent) per kilowatt. For estimating the cost of driving electric motors the energy required per brake-horsepower may be taken as .85 unit per hour.

THE ELECTRIFICATION OF MARINE ENGINEERING WORKS.

A marine engineering and repair works, established in 1888 at the mouth of the Tyne, for the repairing of trawling and fishing craft, which originally consisted of a machine shop about 75 feet long and 40 feet wide, and a blacksmith shop, 75 feet long by 25 feet wide, has recently been developed by the addition of a new foundry and blacksmith shop with the introduction of new high-speed machines and the establishment of a drydock 180 feet long and 40 feet wide. The original plant was supplied with power from gas, but the new works, except the dock equipment, is now operated by electricity. It may be interesting therefore to describe somewhat in detail the way in which electric power has been applied to the driving of machine tools and for other purposes in these works.

The energy is given in the form of direct-current three-wire supply at 440 volts between the outers, and a service is taken from the Corporation service in the street to the main switchboard by means of a Henley cable dividing box. It then passes through the Corporation fuses and Thomson meters onto the main switchboard, which is situated in the machine shop. Here, after passing the main switch, it divides into power and lighting circuits, the latter consisting of five arc-lamp circuits, whose resistances and fuses are mounted on the board, the main lighting of the shops being effected by means of enclosed arcs. For the local lighting of small lathes, etc., incandescent lamps are also installed. The power circuits are nine in number, six of these supplying the machine shop motors, one operating the overhead traveling crane in the heavy erecting shop, another passing to the blacksmiths' shop to operate an electrically-driven power hammer, and another passing to the jetty outside the works in order to operate the machines for heavy iron and steel plates. The demand on the electrical plant is regular throughout the year for a day lasting from 6 A. M. till 5 P. M., the demand constituting a very steady load on the Corporation system.

The present light machine shop more than occupies the space taken up by the whole of the original works, and is about 100 feet wide by 75 feet long; extending from this is an erecting and heavy machine department, and traversing the building containing these two departments are three galleries, one at each end and the third at the center of the building, devoted, respectively, to millwrighting and plumbing, general fitting and brass finishing. Advantage is taken of these galleries for the placing of several of the motors driving the shafting for the ground floor machines, a horizontal drive being thus obtained which is useful in eliminating belt slip. In the erecting and big machine shop some very fine machines for marine engineering purposes are found, among which may be mentioned a large radial driller, which is used for boring propellers, crank webs and the like; another interesting machine is a heavy shaft lathe for turning tail-end shafts, etc., provided with double tool rest; a third machine is a very large table planer having a double tool holder. All these three machines are belt driven from shafting operated by a 40-horsepower motor. Operated from another line of shafting is a wall planing machine provided with three tool rests, and a boring machine which is provided with facing blocks and arms to face up to 6 feet diameter, and is capable of taking a cut on four tools at once. Immediately over these tools is the brass shop, 78 feet long by 18 feet wide, which contains a line of seven lathes for high-speed repetition work, together with a drilling machine equipment. This shop is devoted to repairs and construction of marine engine valves, brasses, etc., and is driven by belt from the same shaft that operates the heavy tools beneath, by means of a 30-horsepower British Westinghouse motor running at 800 revolutions per minute. As, however, this department is frequently called upon to work overtime on repairs to valves, etc., of trawlers having to be out again by the next tide, a separate 10-horsepower motor is capable of being connected to the shafting of the department in order to operate it when the rest of the shop is shut down. In this department we noticed a very interesting Bunsen flame gear, made in the shops, for brazing copper pipes, and a testing machine of a very compact nature.

The handling of the heavy work in the erecting shop is accomplished by means of a three-motor traveling crane of 70-foot span, capable of lifting up to 30 tons, and the floor of the shop is provided with full-gage rails down the center of the shop, with a branch running out to the jetty on which is a bogey truck capable of carrying 30 tons. The complete engine thus taken out of the works is lifted into the boat alongside the quay by means of a large hand-operated jib crane. In the fitters' gallery midway along the building forming the erecting and light machine shops, and which was formerly the main offices and patternmakers' department of the old works, are mounted three of the motors for driving the ground floor machines. These are a 20 and 40-horsepower motor, with interchangeable belting for operating the heavy machines below, the large motor being only used when very heavy work is being undertaken, thus ensuring the utmost efficiency of motor drive on all conditions of load on the shafting. The remaining machine, of 18 horsepower, drives a collection of twenty small lathes and drilling machines in the light machine department. The type of motor panel which is standard throughout the works comprises ironclad gear throughout mounted on wood battens, the starters used being of the Westinghouse type in conjunction with Reyrolle fuses, Stanley ammeters and Berry main switches. In the light machine shop besides the small lathes already mentioned is an interesting boring machine, capable of taking the complete bedplate of a small marine engine, and boring the five bearings at the one time, thus facilitating to a considerable extent the subsequent lining up of the bearings. It is also capable of boring cylinders up to 42 inches diameter. Other machines are a large side planer, a heavy chuck and center lathe, having a gap capable of taking work such as propellers, and which is also capable of screw cutting, and a boring mill capable of taking double cuts on cast iron, and cutting and boring taper or parallel, the particular work for which it is required being in connection with the pistons of marine engines. Among other machines in this bay may be mentioned a fine slotting machine, a twin shaping machine and a horizontal driller. In the elevated gallery for millwrights and plumbers, which was formerly the carpenter shop, is located a 14-horsepower B. T. H. motor for driving most of the above-mentioned tools.

In the blacksmith shop adjacent to the engine works above described are fourteen fires devoted to engineering ship repairing and general smithing. One of these fires is devoted to a special arrangement for heating light forgings with forced draft, by means of which a piece of 8-inch bar can be made welding hot in one-half an hour, consisting of an adaptation of an ordinary open-hearth to a species of regenerative forced-draft furnace for quickly bringing large masses of steel to a welding heat. The forging is done by means of a pneumatic power hammer driven by a Lancashire Dynamo Company's motor of 17 horsepower, running at 800 revolu-

tions per minute. The fan blast is also operated electrically. Mention may be made of an ingenious motor drive which is adopted to overcome the extreme limitation of space which, owing to the extended operations of the firm, has already been found in these works. The Sirocco fan of 9-inch delivery which is used for giving the blacksmiths' blast is sunk into the ground, and the motor driving it is supported immediately overhead on two columns, the belt drive being vertical. The space between the columns is utilized to form a compact tool rack or cupboard for special gear required in this section of the works. Among the special tools in this department may be mentioned a machine for bending ring washers to 16 inches radius out of ¼ by 1½-inch bar in one heat, and an apparatus for making angle-iron rings for condensers out of 3 by 3 by 3¼-inch angle bar, turned and welded under the hammer in one heat. About thirty men and boys are employed continuously in this department.

A special tool-fettling shop for dealing with the needs of the engine works is also equipped with a special forge, having a combined motor and fan. This can be operated when the rest of the blacksmith department is shut down. The foundry is also electrically equipped, having a 15-ton, three-motor electric crane and an electrically-driven fan for the cupolas, while in connection with the dock, the rolls, punching and countersinking machines are electrically operated, together with the machinery for the joiners and carpenters.

It may, therefore, be said that the large increase in the capacity for turning out marine engineering work of this firm is coincident with the adoption of electrical drive, and the last year's output, consisting of twenty-four sets of engines with a total capacity of about 10,000 indicated horsepower, indicates to what extent electricity has been used in this connection.

DIFFICULTIES IN THE ELECTRICAL EQUIPMENT OF SHIPYARD TOOLS.

One of the most difficult problems in the conversion to electricity of a shipyard is the proper equipment of those tools which, dealing with heavy powers, are not continuous in their action. When such a system can be arranged the fly-wheel is, of course, the best means of relieving the electric motor of heavy intermittent strains, because energy stored in the fly-wheel is not lost, but may be reconverted into actual work with a minimum of loss. This form of energy storage is most conveniently applied in the case of punches or shears, where the drive, although positive, permits of the continuous rotation of the motor in one direction. It is then a simple matter either to mount a fly-wheel either on the motor spindle or onto a countershaft gearing with the tool and belt connected to the motor.

The case becomes different, however, when the nature of the operations necessitate reciprocating action of heavy parts. In such instances it is rarely possible to arrange matters so that a continuous forward movement of the motor can be combined with a to-and-fro motion of the driven mechanism. Crossed and open belts have been tried in this connection, but these devices, quite apart from the loss of energy caused by belt slipping, have an uncertain time action which ruins the possibility of fine work and may lead to positive disaster. The difficulty becomes intensified when very heavy weights are in motion, such as in the case of large planing machines used for plates, inasmuch as the inertia of the large mass of metal moving forward produces a large amount of stored energy, very difficult to counteract promptly. For this reason it is not surprising that modern practice in plate planing machines is in the direction of keeping the plate stationary and traversing the planing tool.

It is not often, however, that the electrical engineer entrusted with the recasting of the system of drive in a shipyard has *carte blanche* to scrap every machine which does not satisfy his sense of fitness of things. Instead of this he has often to adapt his drive to machines as they are, and the stationary tool planer is one of his greatest bugbears.

A case in point occurs in a 40-foot plate edge planer, which is capable of cutting 3½-inch steel plates with a quarter of an inch cut at a speed of 20 feet per minute. The stationary tools operate both on the forward and return strokes, the total weight of the moving table and plates being about 12 tons. In order to drive this planer a 23 brake-horsepower electric motor, running at slow speed, was installed, and in order to make sure that at starting or reversing the planer the motor would not flash over at the commutator, it was fitted with inter-pole magnets and designed to give a heavy starting torque. The difficulty of the inertia of the planing machine was overcome by absorbing the energy in a brake—not an economical proceeding, it must be admitted, but the best that could be adopted for such a case. The pulley of this brake, which is of the magnetic type, was attached to the motor shaft, and automatically comes into operation directly a tappet switch is knocked over into the reverse position by an arm attached to the moving planer table. The application of the brake holds the speed of the motor down, and when this is almost at rest the current is automatically reversed by a special switch controlling a solenoid starter. The whole electrical equipment was produced by G. Harland Bowden & Company, of Manchester, who exhibited the same at the Manchester Electrical Exhibition. The reversal of the current disengages the brake, leaving the motor free to start in the opposite direction almost instantaneously. The total time taken in the reversal of the whole of the gearing and table from full speed in one direction to full speed in the opposite sense is only about five seconds, so that the arrangement must be regarded as a very ingenious method of getting over this difficult problem of heavy tool reversal. There are various adjustments on the switchgear which allow of an increase or decrease of speed in reversing as required, which means that the demand for power can be adjusted to within the limits of the motor's capacity, and also that the fluctuations of current are not too heavy for the generating plant. This is an important point where, as is often the case, the shipyard is equipped with its own private station.

Another method of eliminating heavy fluctuations of power on the motor installation, but which is only possible when the electrical engineer can get into preliminary touch with the makers of the shipyard tools before the equipment is finally decided upon, is to arrange that the machines shall themselves bring the work onto the motor gradually. This may be illustrated by the use of gang punches. There is no reason why these should not be constructed so that the punches are not applied all together, but that the work shall come gradually onto the motor by the application, first of one punch, then of the next, to the surface of the plate, although the actual operations of punching in each instance may overlap. The advantage of this is that the series portion of the motor field has an opportunity of "building up" and eliminating or reducing the chances of flashing over.

It is evident that the whole subject of shipyard equipment cannot be discussed in a short article such as this, and the above notes are merely intended as an indication, firstly, of the class of difficulties which have to be faced, and, secondly, of the lines in which they can be most successfully overcome. The subject of electrical operation of shipyards is not only most interesting but is the basis of expert experience, which can only be obtained by a considerable amount of special attention.

ELECTRICAL WIRING ON STEAMSHIPS.*

The application of electricity to the lighting of steamships practically coincides with the introduction and evolution of the electric incandescent lamp, although long before the glow lamp made its appearance electric arc lamps and Joblochkoff candles were freely used for the lighting of decks on board ship, and the advantage of the new illuminant for loading and discharging cargo for naval purposes became rapidly apparent. It was not, however, until the incandescent lamp was put on the market that the lighting of the accommodation of steamships on a practical scale became possible. The first vessel so equipped was the American steamer *Columbia,* which was fitted in 1880 under the direction of Mr. Edison, the installation consisting of 115 lamps of 10-candlepower, with two small 6-kilowatt dynamos driven by belts from counter-shaft. So successful was this installation, and so much was the superiority of the electric light recognized, that in less than a year we read that electric lighting was fast superseding oil lamps on board steamships, and now no vessel is considered complete without the electric light, and it is almost impossible for a charter to be secured unless the ship be so equipped. During the past thirty years so great has been the development of electricity that it is used on board ship not only for lighting, but also for all forms of electric power, such as driving winches, pumps, cranes, forced-draught fans and other auxiliary machinery, besides being employed for driving ventilating fans, operating various heating and culinary appliances, bells, telephones and other devices too numerous to be detailed here.

One of the first vessels in England to be lighted electrically was the Cunard liner *Servia,* which was fitted in 1881 with 117 incandescent lamps and two arc lamps. In contrast to this, the Cunard liner *Mauretania,* fitted in 1907, twenty-six years later, has 6,300 electric lamps and over 2,133 horsepower in motors and other power appliances.

In planning out the electrical equipment of a modern vessel a great many factors have to be taken into consideration. For small-cargo ships fitted with 100 to 200 lights it is a comparatively simple matter to divide these up into three or more circuits, but where larger installations have to be dealth with, such as in large passenger liners, the distribution arrangements are more complicated. For instance, there will always be certain lights required night and day, such as lights in machinery spaces, galleys, pantries, and lights for the use of the officers, crew, etc. Then, again, it must be taken into consideration that a large number of lights are in use in the evening, but not by day or night. These include saloons, music rooms, smoke-rooms, etc. Also fans, punkahs, etc., are required only for hot climates, whereas heaters would only be required in cold climates. Cargo clusters, or arc lamps, would only be required when the vessel is in port, besides power for driving winches, cranes and other loading appliances, and if the vessel travels via the Suez Canal the searchlight would require to be brought into operation during its passage through the canal. The wiring of the ship has therefore to be carried out in such a way as to arrange the lighting and power circuits in the most convenient manner, having regard to the particular circumstances in which the various items are required to be available.

The supply of electrical energy to the different circuits is controlled from the engine room (or dynamo room) by means of the main switchboard. In small installations this consists of a single slab of enameled slate or marble, on which are mounted one single-pole switch for each section into which the installation is divided, the corresponding double-pole fuses, ammeter for registering the flow of current from the dynamo, voltmeter for indicating the electrical pressure, a pilot lamp directly connected to the terminals of the dynamo, and earth lamps to detect any leakage that may occur. For larger installations, however, the boards are usually constructed in sections, the positive and negative terminals being frequently mounted on separate slates with wood or ebonite fillets between the slabs. When there are two dynamos the switches are of the change-over or two-way type, so that any single circuit can be fed from either machine, but not from both sets at one time, and in addition two dynamo panels are usually added, one for each machine, having mounted thereon a double-pole switch and fuse, so that either dynamo can be switched entirely off if not required. For very large installations, where there are three or more dynamos, it is usual to run the machines in parallel, that is, practically as one large generator, special arrangements being provided in the switchboard for switching any of the dynamos in or out of circuit according as the load may increase or diminish. A photograph and description of the port section of the main switchboard of the *Mauretania,* which was fitted by Messrs. W. C. Martin & Company, Glasgow, is shown in another article in this issue, describing the electrical equipment of the *Mauretania.*

As regards wiring, there are two methods employed, viz.: single wiring and double wiring. The former system consists in running one conductor only, the return lead from the light being soldered to a brass screw which is tapped into the framework of the ship, thus making the hull of the ship itself the return circuit. It is, however, not an altogether satisfactory system, for various reasons. First, the iron or steel ship, being a conductor of electricity, may on the passage of the current become a huge floating magnet; this, of course, affects the deviation of the compasses. To overcome this it is necessary to double wire the ship for a radius of 15 to 30 feet from the compasses, or, as is often done, to wire the whole of the forward part of the ship on the double-wire system from a line 30 feet aft of the compasses. Secondly, it must be remembered that a ship is a metallic body in direct contact with earth; that is, earth is everywhere, and there is at every point the increased risk of the current being earthed, owing to the increased tension between the insulated conductor and the ship, which is another source of danger. Then, again, the joints of the return leads to the hull of the ship are a frequent cause of trouble, and electrolysis is very apt to occur, which causes corrosion and subsequent breakdown. It is not so much of a saving as might be generally supposed over the cost of double wiring. It is true that there is only one conductor instead of two, but two cables together can be erected for practically the same cost as a single cable, and besides, the extra labor involved in making the connections with the hull adds considerably to the expense of a single-wire outfit. Another point is that owing to the fact already referred to, of the ship being practically always in contact with the earth, a greater electrical tension exists between the conductor and the ship than with double wiring. The tendency to earth is therefore greater, and the insulation of the conductor requires to be nearly doubled, thus again increasing the proportional cost of single wiring. Before leaving this system a few words might be said about concentric wiring. This consists of two conductors, an inner and an outer, separated by the usual insulation. The outer conductor is generally uninsulated, thus making the system a modification of the single-wire system. It is, therefore, open to the same objections as ordinary single wiring, but if the outer conductor be insulated the system becomes a safe method. Requiring, as it does, however, special joint boxes and connections, it is not so well adapted for extensions or repairs, especially when the ship is at a foreign port, and on this account it is not extensively used.

The system most generally used on board ship is the double-wire system. The principle of this system is that all electric wiring on land, viz., the running of two wires parallel to each other and connecting the lamps across them. In practice, however, the wires do not always run in pairs, the return being

* Contributed by Messrs. W. C. Martin and Company, 10 West Campbell street, Glasgow.

often made by a general wire serving several circuits, but the essential condition is that both lead and return wire are insulated, not only from one another, but also from the earth. By this means a completely isolated metallic circuit exists throughout, the compasses are not thereby affected, and any faults on either wire are readily detected and repaired. We shall now consider the class of wire to be used on board ship, and the methods to be adopted for installing same. First of all, it must be remembered that the vessel is not simply a great iron or steel house and nothing more. If that were all, the insulation of the wires and the erection would be a comparatively simple matter, but in the case of a ship several conditions exist which do not prevail on land. First of all, there is always moisture present on board ship, and where moisture exists the difficulty of maintaining the insulation increases. The moisture may be due to the condensation of steam from the various steam pipes, or the continual sweating which is always present on large iron surfaces, or it may be due to spray, in which case the salt water has a very deleterious effect on both the wire and the insulation. Then, again, a ship is continually subjected to vibration, partly owing to the propelling and other machinery, and often owing to being tossed about in stormy weather. The wiring and other fixtures must therefore be of sufficient mechanical strength to withstand not only constant vibration, but the strain of sudden shocks. In the early days of electric lighting there was practically no provision made by the shipbuilders for the safe passage of the electric wiring, and in a great many cases it did not matter to them where or how the wires were placed as long as they were out of sight. The wiring was accordingly concealed behind paneling, or anywhere out of the way, and when faults occurred it was no easy matter to locate them. Now it is the custom to armor the wires and run them openly, or to have special moldings made in the decorative paneling to receive them, these moldings being easily removable at any time it is desired to get at the wires. The great thing is to have the wiring accessible at all parts of the ship. The methods of leading the wires are various. It might be thought that running the wires throughout the vessel in piping would be the most satisfactory method, but experience has proved this to be otherwise. Both mechanically and electrically tubes are a source of trouble. Electrically owing to the fact that the tubes harbor moisture, on account of the sweating before referred to, which is very destructive to the insulation, and mechanically because the tubes very often form a temptation to irresponsible persons to hang on to them as if they were hand rails or horizontal bars. Besides, if the wires are encased in tubes they are not so accessible as if run openly. At the same time, however, there are certain exposed parts of the ship where it is essential to use tubing, such as exposed decks and leads to mast and side lights, and where this is the case nothing lighter than well-galvanized screwed gas tubing should be adopted, the light forms of steel tubing used on land being quite useless for ship work. Wood casing is still extensively used on board ship, as on land, to protect the wires, and this makes quite a safe and good job for passenger accommodation, the wires being of copper of the highest conductivity and insulated with pure and vulcanized rubber, the whole vulcanized together, taped, braided and compounded. The wood casing should be of a good quality, preferably teak. The disadvantage of this system is that where there are a large number of wires the casing becomes more or less unsightly, unless provision be made in the moldings, etc., to receive the wires. Wood casing is not at all suitable, however, for cargo and machinery spaces, and places where there is danger of mechanical injury. In such parts of the vessel there is nothing better than a spirally-wound sheathing of galvanized iron or steel wires to encase the cables, the armor being laid over a packing of hemp and waterproof compound surrounding the wire. Sometimes a lead sheathing is used under the armor, but experience has shown that cables armored in this way do not stand exposure to sea air for many years, owing to the electro-chemical action between the lead and the zinc of the galvanized iron armoring, which very rapidly destroys the cables. Lead sheathing alone forms an excellent covering for wires on board ship, but it can only be used where it is not exposed to mechanical injury. It must also be fitted on the surface, and not in casing or behind moldings, or it will very rapidly deteriorate, owing, it is supposed, to the destructive action of the salt air and vapors arising from the wood, especially in hot climates. A further protection is often required for armored wires in cargo holds or in other places exposed to extreme damage, and nothing better can be devised than to clamp the armored wires in ⅜-inch channel irons with a heavy iron cover over all.

Twin cables are often used in preference to two single cables for submains and leads to lights. They are proportionately stronger than two single cables, besides being much easier to handle. A very neat and effective job is made by running twin lead-covered wires in the accommodation, fastened openly to the woodwork with brass clips, and if the lead sheathing is of flat or rectangular section, even where a number of wires are laid alongside one another, they are not at all obtrusive and have the appearance of a neat molding.

It used to be the practice to have the leads from the lights jointed to the wires at the nearest point, but as joints are a continual source of trouble, owing to more or less defective workmanship, they are never used in modern ship installations unless under very exceptional circumstances. Even where two or more lengths of cable are connected up together an extension box is employed. This admits of the two cables being clamped together by means of special terminals mounted on a slate or porcelain base. It is often the practice to run the leads to each light direct from the distribution boxes, with a safety fuse to each light. A more convenient method, however, is to connect the leads from the lights by means of extension boxes to the submain cables leading from the distribution boxes, thus avoiding the excessive use of small distributing boxes in the passages and elsewhere. The distribution boxes should be of substantial make, slate (polished or unpolished) being used for the base, and the fuse holders should be of the bridge or handle type, easily removable, to allow of renewal at a moment's notice. In the larger sizes of fuses it is advisable to have the carriers of some unbreakable material such as eternite. The boards should be encased in boxes of good, solid teak, dovetailed and screwed together, but in positions liable to damp or to mechanical injury they should be fitted in iron cases, made thoroughly water-tight. In saloons and other public apartments it is better to form a receptacle behind the paneling to take the fuseboards, the paneling itself being hinged to form a door or lid to allow of access.

There are other systems and methods of wiring in existence, but as most of these are of recent introduction, sufficient time has not elapsed to allow of their advantages or disadvantages to be made thoroughly evident. A passing reference may, however, be made to the three-wire system, which is rapidly coming to the front, especially for warships and other very large vessels having a considerable amount of electrically-driven machinery. As its name implies, this arrangement consists of running three conductors in parallel instead of two, with 220 volts across the outer conductors, this pressure being used to operate the power appliances, while the leads to the lights are connected between the inner and one or other of the outer conductors, thus forming a two-wire system at 110 volts for lighting. The great advantage of this system is the saving in copper effected by utilizing the higher voltage for power purposes, which reduces the size of the power cables very considerably.

Owing to the limited space allotted for this article a great many features have had to be omitted, but enough has been said to show that the fitting of an electric light installation on board ship has to be very carefully carried out, the materials used ought to be of the very best quality and of substantial design, and, above all, handled by skilled and careful workmen, otherwise deterioration will very quickly result. Unfortunately in these days of excessive competition the tendency to cut prices is so great that a large amount of inferior material and workmanship is undoubtedly installed on board ships, a state of affairs which for the interests of the owners and the safety of the passengers and crew ought not to be allowed to exist, and shipbuilders, superintendents, consulting engineers and others would do well to carefully consider what kind of job they are likely to get, and have expert advice on the subject before accepting, as is usually done, the cheapest offer.

ELECTRICAL EQUIPMENT OF R.M.S. MAURETANIA.

The electrical equipment of modern ocean-going liners of the class to which the *Mauretania* belongs forms an important feature of the design of such a vessel, both from the point of view of comfort and convenience to passengers and also in connection with the auxiliary machinery on board ship.

The power station of the *Mauretania* consists of four shunt-wound turbo-generators of the Parsons type, each having a capacity of 375 kilowatts at 110-120 volts. The turbines are designed to give full load when exhausting into a back pressure of 10 pounds. The speed of the turbines (1,200 revolutions per minute) is somewhat low considering the capacity of the machines, and each is capable of an overload of 10 percent for two hours. When on trial most satisfactory results were obtained from these sets, and the following figures were arrived at:

Water consumption at half load, 60.60 pounds per kilowatt-hour; three-quarters load, 52 pounds per kilowatt-hour; full load, 46 pounds per kilowatt-hour; the back pressure in each case being approximately 5 pounds.

This power station supplies current for the lighting of the ship, for the driving of all auxiliary machinery on board ship, for hoists, ventilating fans, heating appliances, electric light and heat baths, and also for medical work.

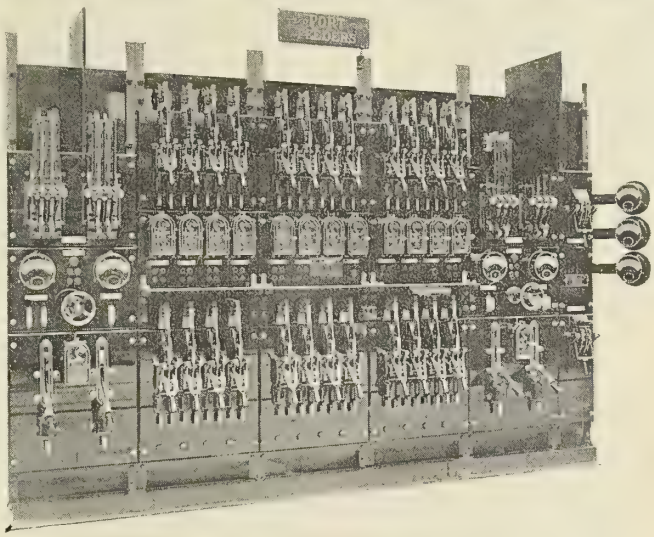
The most interesting feature of the installation is, perhaps, the switchboard, which was constructed by Messrs. Ferranti, Ltd., of Hollinwood, Manchester, and fitted by Messrs. W. C. Martin & Company, Glasgow. This consists of two similar boards for the port and starboard sides of the ship, respectively. These two boards are separated by a bulkhead, so that any accident in the electrical supply is isolated, though the boards are worked together under normal conditions through disconnecting switches. Each board consists of two generator panels and twelve feeder panels, excluding the disconnecting panel referred to.

The generators are connected up to the switchboard through automatic overload and reverse current time limit circuit breakers, one on each pole. The relays which control these breakers are of the Ferranti moving-coil type, and operate on a 15-second time limit overload of 85 kilowatts; 10 seconds, 145 kilowatts, and 5 seconds, 200 kilowatts overload, a dead short operating instantaneously.

In the event of two machines running in parallel, and for any cause one machine should start to motor the other machine, the second machine would be isolated by the reverse current relay after a time limit varying inversely with the strength of the reverse current.

The design of such large capacity circuit breakers (the full load current of each machine being over 3,250 amperes) is an important feature. It will at once be understood that a breaker to carry this current without undue heating must be liberally designed, and therefore of substantial dimensions. At the same time it must be easily operated and require little effort to close. With the Ferranti type circuit breaker a link motion is incorporated, which overcomes any difficulty in operation. The design of this type of circuit breaker is interesting, and a few details concerning it would not be out of place.

An important feature in its construction is that the carbon blocks are placed at a very long distance away from the main carrying contact. It has been sought also to reduce as much as possible the weight, which, acting at a large radius, is a matter which must be appreciated in the efficient production of such a breaker. The subsidiary contacts are also arranged



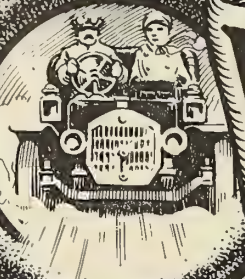
PORT SWITCHBOARD OF THE MAURETANIA.

to form an ample protection to the main contacts of the circuit breaker. All the current-carrying parts are liberally designed and exceptionally massive, producing altogether a rigid apparatus. For example, each bus-bar is of 4 inches cross-section. The cables and leads are also correspondingly heavy.

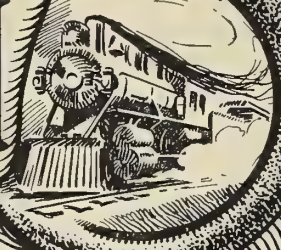
The feeders are designed to carry 600 amperes each, and are controlled through automatic switches fitted with overload relays. The feeder circuit breakers have double trip coils. The object of this is as follows:

All feeder circuits throughout the vessel are protected by means of fuses. Fuses, as is well known, possess a certain time lag. In order that any circuit should not be immediately isolated from any cause a momentary current of full load capacity has been thrown upon the circuit. The circuit breaker controlling this section of the board should also possess a certain time lag. On the other hand, should a severe short occur it is essential that the circuit breaker should operate immediately. The series trip coil on the breaker is therefore set high, so that it does not operate at all unless there is an overload of the nature of a short circuit on the feeder. The shunt trip coil, however, operates through a time limit relay, which ensures the circuit breaker not tripping on any momentary rush of current, and allowing the fuses on the other parts of the circuit having an opportunity to operate first and so facilitate the location of any faults which may have developed.

Separate feeders are taken from the switchboard to supply the various motor circuits and lighting circuits, and separate sections are also made of the heating and medical circuits.



VANADIUM



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3	65,100	34,400	18.5	17.2	1 Inch
4	56,900	22,800	57.5	43.7	1 Inch
5	59,500	22,000	52.0	37.6	1 Inch
6	51,100	18,100	65.0	45.3	1 Inch
7	59,200	23,000	50.0	39.1	1 Inch
8	32,000	17,500	21.0	18.8	1 Inch
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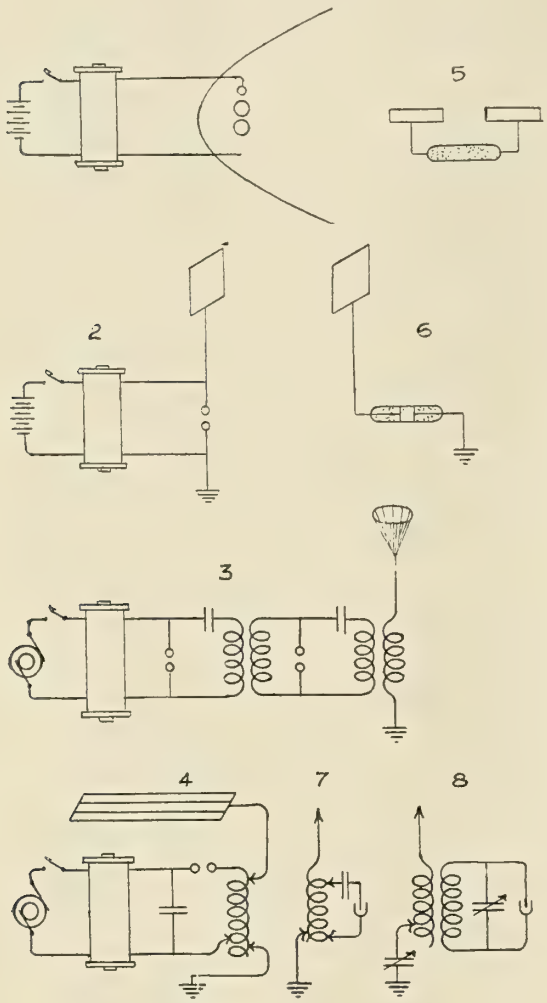
DEVELOPMENTS IN WIRELESS TELEGRAPHY.*

BY COMMANDER S. S. ROBISON.

The purpose of this article is to show briefly to what extent wireless telegraphy has developed in nineteen years. Marconi transmitted a distance of two miles in 1895; in 1896 he transmitted a distance of four miles. In 1897, using vertical wires 150 feet high, signals were successfully exchanged at a distance of about nine miles. A distance of thirty-four miles was reached, and in 1899 on land and between two British men-of-war about sixty miles apart at sea, also eighty-five miles, partly over sea and partly over land.

The apparatus was a 25 horsepower, the frequency of alternating current being 50 cycles per second. From it signals



ARRANGEMENT OF WIRELESS APPARATUS.

were sent across the Atlantic and received on an aerial about 400 feet long, suspended from a kite.

So that in less than eight years after wireless telegraphy was shown to be practical a range of wave lenghts from 1.3 up to 1,500 meters had been used.

The method of construction shown in Fig. 3 was modified so as to omit one of the oscillation transformers, and with this omission this method of generating electric waves is still in use and is commonly called that of inductive coupling.

Professor Slaby subsequently produced, with Count Arco, what was known as the Slaby-Arco system, which used the method of direct connection or direct coupling shown in Fig. 4. This became the general method of coupling transmitters. Stone, however, used the method of inductive coupling both for sending and receiving.

The first portable and convenient means of measuring wave lengths produced by oscillating circuits were made by the Slaby-Arco Company in Germany about 1902.

The use of wave meters showed that, in general, circuits tuned to resonance and connected to each other, as shown in Figs. 3 and 4, generated and radiated waves of two lengths, one longer and one shorter than that which would have been produced by either circuit if oscillating free from the influence of the other.

A difficulty confronted the designers; if they used the plain aerial and generated waves of but one length they were limited to small powers and short distances.

If they used direct or inductively-connected tuned circuits they produced waves of two lengths, only one of which could be received, and part of the energy was consequently wasted.

So that, although the means were discovered of generating waves of any desired length and radiating any desired amount of power, difficulties arose in the use of the large powers which were found to be necessary to send long distance—two waves were generated where only one was desired. This difficulty was partially overcome by weakening the mutual induction between circuits, so as to bring the two waves nearly into coincidence in length; but, in general, the existence of two wave lengths interfered with the sharp tuning which is necessary to prevent interference in receiving.

In 1906 M. Wien observed that while using a spark gap made of metal surfaces placed very close together his measuring instruments only indicated one wave in the radiating circuit—the aerial.

Investigation of this phenomenon appeared to indicate that the gap, possibly on account of the cooling effect of the large surface and mass of material used, regained its di-electric strength to such an extent after two or three sparks had passed that the remaining energy was not sufficient to break the gap down again, so that the closed circuit made but two or three oscillations.

The manner in which the closed circuit transfers energy to the open circuit it appears that this form of spark gap, made up of a number of very short gaps between metal plates, prevents the retransfer of energy from the open to the closed circuit after the closed circuit has completed the first transfer and is momentarily stopped.

With the spark gap open, whatever vibrations are set up are not in tune with those in the open circuit and they absorb little energy from it.

We have two ways of generating electric waves of any desired length, namely, weakening the mutual induction between coupled circuits and by means of the quenched spark.

Aerials generating short wave lengths are more efficient radiators than those generating long ones; but short wave lengths suffer more absorption over land and sea than long ones.

For over-land communication the greater radiation efficiency of the oscillations producing short wave lengths is counteracted at much shorter distances by the greater absorption of short waves. This absorption varies greatly with the character of the land surface—whether wet or dry, level or hilly or mountainous.

It was demonstrated that for short distances the attenuation due to distance varies directly as the distance and does not fall off according to the law of inverse squares.

The distance which signals can be received from an aerial varies directly as its vertical height and directly as the amount of oscillating current in it; also directly as the height of the receiving aerial, so that the efficiency of two similar aerials

* Abstract, *Journal, American Society of Naval Engineers.*

for wireless telegraph purposes varies as the square of their height.

Taking the lower limit of received current which will produce audible signals as 1/100,000 of an ampere, experiments indicate that in order to communicate 400 miles, with masts 200 feet high, using a 300-meter wave, we must have an oscillation current in the aerial of 1 ampere; to ensure good communication we should have 4 amperes.

To ensure good average communication at 2,500 miles, with masts 450 feet high, we would require, with a 6,000-meter wave, a current of 50 amperes in the aerial to secure readable signals, and about 200 amperes to ensure good communication.

With parity of other conditions vertical wires 20 feet long are sufficient for communicating one mile; 40 feet, four miles; 80 feet, sixteen miles.

This law is not complete, as it failed to take into account the effects of absorption.

The recent Brant Rock experiments are the most extensive series of observations on absorption, the results of which have been published.

It appears we have certain means of generating electric waves of any desired length. We cannot say that they are simple.

Sir William Crookes included in the term receivers, which he knew only as short resonators with which waves were detected by observing the sparks passing between their terminals, apparatus which we now divide into three classes: Receiving circuits, detectors and means for making the action of the detectors audible or visible, such as telephones, amplifiers, Morse writers or recorders.

Marconi, in his experiments used as a receiver the apparatus shown in Fig. 5—two metal or tinfoil-covered glass plates connected by a tube containing metal filings.

In 1897 Marconi fixed the proper length of the plates of his receiving apparatus to make them resonate by using plates of tin foil pasted on glass and making a cut across the foil with a very sharp penknife, and bringing it close to the sending apparatus shown in Fig. 1 in such a position that the strips of tin foil are parallel to the line joining the centers of the oscillating spheres, when sparks would jump across the cut.

When the length of the strips were adjusted to approximate resonance the sparking occurred at the greatest distance from the oscillation producer; he brought it to the sending apparatus and made his adjustments there and then set it up elsewhere.

When he used long, vertical wires as senders the method of tuning the receiving set by means of the sending set in its immediate vicinity was not practicable. In May, 1897, with the sending apparatus connected to a vertical wire 150 feet high, the receiving apparatus was at first connected to a wire 90 feet high, about 60 feet above sea level, and for two days attempts to communicate over a distance of three and a half miles were unsuccessful. On the third day the receiving apparatus was carried down to the beach, at sea level, and connected to the 90 feet of wire by the additional 60 feet necessary to reach sea level, making 150 feet in all, and communication was immediately established.

The direct-connected sending apparatus shown in Fig. 4 came into use, direct-connected receiving apparatus was introduced, the connections being as shown in Fig. 7, except that the arrangements for variable connections in both inductance and condenser, and which are used for tuning both the closed and the open circuits, were not introduced at this time, but were a later development.

Stone developed a method of sharp tuning by the introduction of an intermediate-tuned receiving circuit, introduced between the open circuit and the closed detector circuit.

Both the weeding-out circuit, as proposed by Stone, and the Fessenden interference preventer are useful under certain conditions, but usually the inductively-connected tuned receiving circuit (Fig. 8), without any intermediate circuit, is that in general use.

Receiving circuits are not in general more delicate except in the sense of being more selective.

For ordinary ship communication the reliable operating distance of coherers, with expenditure of 2 to 3 kilowatts in the sending apparatus, was from fifty to seventy-five miles.

Many other kinds of detectors were discovered, which could be used with a telephone, but none of them proved to be sufficiently reliable to be placed in general use until the electrolytic detector was developed by Fessenden in 1902.

The introduction of detectors, such as the electrolytic, tripled the working range of telegraph sets.

In 1905, General Dunwoody, U. S. A., introduced carborundum crystal detectors. Crystal detectors are now in general use.

Considering the requirement of darting the sheaf of rays in any required direction. This has not been satisfactorily accomplished except for very short distances.

Marconi generated free electric waves in the focus of parabolic mirror and directed them towards his receiver, which was placed in the focal line of the mirror, but the distances that he was able to cover by this method were so short that he soon discarded this for the vertical earthed-wire transmitter, which generated earthed waves.

Surrounding this vertical wire with a reflector by which the waves could be directed was manifestly impracticable, and no serious efforts in this direction were made for a number of years.

Artom attempted to generate elliptically shaped waves by the introduction of multiple aerials.

Guarini attempted actual direction by means of refracting the waves. Marconi discovered that a transmitter, having a large portion of the aerial horizontal, received more strongly in the direction away from which the horizontal wire pointed and sent more strongly in the direction from which it received the best.

Horizontal aerials radiating from a common center, like spokes of a wheel, were set up on shore in such a way that each one could be connected at will to a common vertical aerial. It was found possible to determine the direction of the sending vessel from the station on shore by connecting the horizontal parts in succession to the vertical parts. The strongest signals were received when the vertical part was connected to that spoke of the wheel pointing away from the direction of the sending vessel.

The trans-Atlantic wireless stations have the horizontal portions of their aerials pointed directly away from each other. This method of directive sending and receiving is only applicable to shore stations. No satisfactory explanation of the cause of the directive effect has yet been offered.

Stone, in the United States, based his attempts at directive receiving on the fact that two vertical wires in a plane at right angles to the direction of the waves would have oscillating currents of the same phase and strength induced in them, which could be made to neutralize each other and produce zero signals.

An unsuccessful attempt was made to determine the relative bearing of two ships from each other by this method.

The importance of having a reliable means of determining the direction from which wireless telegraph signals are coming cannot be overestimated. Being able to direct them is of equal importance.

One operator can be ready to receive two wave lengths at the same time, making use of two receiving sets, one connected to each ear; but this does not cover the case. The custom is to have the receiving circuits broadly tuned for listen-

ing in, and then adjust them as sharply as to be non-interfering.

Wireless telegraphy is indispensable to the efficient operation of navies, both in peace and war.

Electric Steering Gear.

In general, electric steering gear involves the principle of operating the auxiliary steering gear mechanism by an electric motor in place of the steam engine, which motor may obtain its power directly from dynamo room feeders, and will operate in synchronism with the rudder; that is, the motor is started and stopped by means of a powerful automatic controller each time the rudder itself is started and stopped. The electric gear consists of a disc-brake, a main automatic controller with a resistance, a limit switch and follow-up drum master controller. The master controller consists of a small follow-up controller installed in the steering engine room, and operated by connections to the tiller ropes or telemotor in a similar manner to that employed in operating the valves of the steam engine. This follow-up drum control is also connected to the main driving shaft, and in this manner a follow-up motion is produced, which is in all respects similar to the control obtained by the steam engine equipment. The change from steam to electric, or electric to steam drive, can be accomplished by throw-over clutches or equivalent means.

The control equipment acts to automatically accelerate the motor and to provide a slow speed and bring the motor quickly to rest. In case of overload, the control equipment operates to limit the motor current and torque to a predetermined safe value. A movement of the steering wheel on the bridge produces a corresponding movement of the control mechanism in the steering engine room, which through the control equipment starts the motor, and then by mechanical connections from the rudder to the control mechanism in the steering engine room, before mentioned, a follow-up is effected and the motor automatically stops at the desired angle. A reverse motion of the steering wheel will revolve the control equipment in an opposite direction, and starts the motor and rudder in the opposite direction.

In order to prevent the rudder from jamming a limit switch is provided, which will automatically shut down the motor at extreme angles of travel. It is possible, however, to operate the equipment in the reverse direction after the limit device has operated at one of the extreme positions.

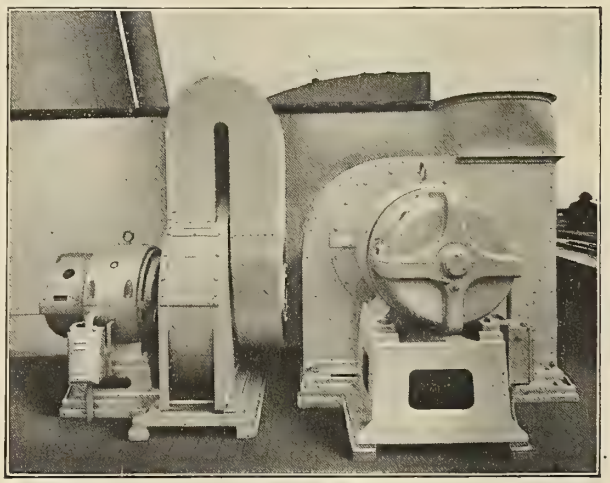
The steering engine and electric motor are provided with mechanical clutches on the main engine driving shaft, so that either the engine or the motor may be thrown into gear with the shaft as desired.

The connection between the tiller rope and telemotor and the follow-up drum in the steering engine room and the connection between this drum and the engine shaft are so proportioned that the results when steering with the electric gear will be similar to those obtained with the steam engine; that is, a given throw of the steering wheel will produce the same angular travel of the rudder with the electric gear as with the steam. Any movement of the steering wheel on the bridge corresponds to a certain number of degrees of the rudder in one direction, and turns the master controller a proportionate number of degrees, and is followed immediately by the starting of the motor and turning of the rudder in that direction; the motor-driving shaft operating while driving the rudder to return the master controller toward the initial or center position. When the motor has reached the angular position, as indicated by the steering wheel, the motor-driving shaft will have made the proper number of revolutions to bring the master controller back to the initial position, at which point the control circuits in the master controller are broken and the motor is stopped.

The reversal of the movement of the steering wheel reverses the rotation of the motor, and the rudder is turned in the opposite direction, which will revolve the master controller back towards its off position, and the motor will continue to revolve until the rudder is in a position corresponding to the steering wheel, at which point the master controller is in its off or stop position. The manufacturers of the steering gear described in this article are the Williamson Bros. Company, Philadelphia, Pa.

Ship Ventilation.

The art of ventilation, which is now generally recognized as a most important branch of sanitary science, has probably received even more attention at the hands of the builders of large passenger vessels than has been the case with architects of modern buildings. Certain is it that shipbuilders have far greater difficulties to contend with. For instance, there is a larger number of persons on board in comparison to the space available than on land, involving consequently a larger volume of air than is usually required in buildings, excepting, of course, theatres, etc., where, however, the occupation is only temporary. Further, this volume of air has to be distributed



VENTILATING FANS ON BOARD THE OLYMPIC.

among innumerable cabins at such a low velocity as not to cause a draught—so easily noticeable in confined spaces. Provision must also be made for warming the air, as well for its removal when vitiated. And all this must be accomplished with the utmost regard to economy of space. Artificial ventilation is now rapidly superseding natural ventilation at sea, as it has been doing for some time past on shore. The difficulty of obtaining with cowls alone an adequate and regular supply of fresh air below deck, and of controlling and distributing the air current produced by them, has led the modern shipbuilder to adopt mechanical ventilation, with its small and compact units of comparatively high volumetric capacity. No better example of up-to-date practice could be found than on the White Star liner *Olympic*, the largest vessel afloat. Messrs. Harland & Wolff have equipped it with no fewer than seventy-five electrically-driven Sirocco fans, measuring from 20 inches to 50 inches in diameter. Some of these fans, which are connected to heaters, distribute the fresh warmed air throughout the ship, others are used for extraction purposes, while twelve large fans are employed for the ventilation of the stokeholds.

LAUNCH OF THE TITANTIC.*

The general arrangements for launching the 45,000-ton White Star steamship *Titanic,* which occurred on May 21 at the Harland & Wolff shipyard at Belfast, were similar to those in the case of the sister ship *Olympic,* which were described in the December, 1910, issue of INTERNATIONAL MARINE ENGINEERING. The vessel was held on the ways by hydraulic triggers, only requiring to be released by the opening of a valve in order to let her glide into the water. Her launching time was sixty-two seconds, her speed 12 knots and her weight about 25,000 tons.

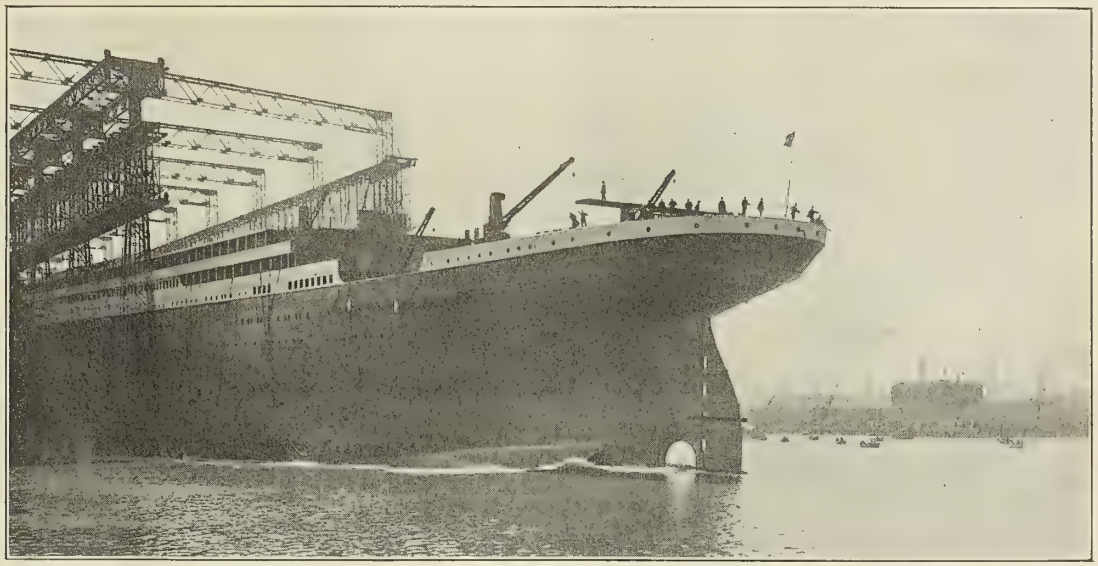
The *Titanic* is of the same design as the *Olympic.* The following are the leading dimensions:

Length over all	882 ft. 9 ins.
Length between perpendiculars	850 ft.
Breadth, extreme	92 ft. 6 ins.
Depth, molded, keel to top of beam, bridge deck	73 ft. 6 ins.
Total height from keel to navigating bridge	104 ft.
Gross tonnage (about)	45,000 tons.
Load draft	34 ft. 6 ins.
Displacement (about)	60,000 tons.
Indicated horsepower of reciprocating engines	30,000
Shaft horsepower of turbine engines	16,000
Speed	21 knots.

The *Titanic* is a triple-screw steamer having a combination of reciprocating engines with a low-pressure turbine. The reciprocating engines exhaust into the low-pressure turbine, which drives the central propeller. The reciprocating engines which drive the wing propellers are sufficient for manœuvring in and out of port and going astern. There is no necessity for an astern turbine, which is required in steamers fitted with turbines only. There are twenty-nine boilers for the ship, having in all 159 furnaces. All of the boilers are 15 feet 9 inches in diameter; but twenty-four are double-ended, being 20 feet long, while five are single-ended, being 11 feet 9 inches long. The shells of the latter are formed by one plate; the others have, as usual, three strakes. At each end there are three furnaces, all of the Morison type, with an inside diameter of 3 feet 9 inches. The working pressure is 215 pounds, and this under natural draft. The boilers are arranged in six watertight compartments, and owing to the width of the ship it has been possible to fit five boilers athwartship. The boiler compartment nearest the machinery space accommodates the single-ended boilers, and these are arranged for running the auxiliary machinery while the ship is in port, as well as for the general steam supply when the ship is at sea.

In each of the five large boiler rooms there are two See's ash ejectors, and in addition there are four of Railton & Campbell's ash hoists for use when the vessels are in port. A large duplex pump of Harland & Wolff's own make is fitted in a separate room in each boiler room, the advantage being that the working parts of the pumps are not injuriously affected by dust. The boilers are fitted with the Ross-Schofield patent marine boiler circulators. The exhaust turbine, instead of being in the same engine room with the two sets of piston engines, as in earlier ships, is accommodated in a separate compartment abaft the main reciprocating engine room, and divided from it by a watertight bulkhead. In the reciprocating engine room there are two sets of main engines—one driving the port and the other the starboard shaft. In the wings there are the main feed and hot-well, bilge, sanitary, ballast and fresh-water pumps, and a contact and surface heater; while on the port side a space has been found for extensive refrigerating plant under the immediate observation of the engineers.

The two sets of reciprocating engines—one driving each wing shaft—are of the four-crank type, arranged to work at 215 pounds per square inch, and to exhaust at a pressure of about 9 pounds absolute. These engines are on the balanced principle. The high-pressure cylinder is 54 inches in diameter, intermediate cylinder 84 inches, and each of the two low-pressure cylinders 97 inches in diameter, the stroke being 75 inches in all cases. The exhaust steam turbine, by which the central screw will be driven, is of the Parsons type, to take exhaust steam at about 9 pounds absolute and expand it down to 1 pound absolute. The condensing plant is designed to attain a vacuum of 28½ inches (with the barometer at 30 inches), the temperature of circulating water being 55 degrees to 60 degrees F. The rotor is built up of steel forgings, is 12 feet in diameter, and the blades range in length from 18 inches to 25½ inches, built on the segmental principle, laced on wire through the blades and distance pieces at the roots, and with binding soldered on the edge as usual. The length of the rotor between the extreme edges of the first and last ring of blades is 13 feet 8 inches. There is, as has been



THE WHITE STAR STEAMSHIP TITANIC, SISTER SHIP OF THE OLYMPIC, ENTERING THE WATER.

* Welin davits are fitted throughout.

said, no astern turbine, as the center shaft is put out of action when the ship is being manœuvred. The bearings, thrust and governor are of the ordinary type adopted in Parsons turbines. The turbine can be rotated by electric motor, and the usual lifting gear for the upper half of the casing and the rotor is also actuated by electric motor. The rotor weighs about 130 tons, and the turbine complete weighs 420 tons. The turbine shaft is 20½ inches in diameter, the tail shaft 22½ inches, each with a 10-inch hole bored through it.

The propeller driven by the turbine is built solid, of manganese bronze with four blades, the diameter being 16 feet 6 inches. It is designed to run at 165 revolutions per minute when the power developed is 16,000 shaft-horsepower. As usual with turbine condensers, the inlet is of the full length of the condenser, and is well stayed vertically by division plates. In line with these there are in the condenser corresponding division plates, which secure an equal distribution of steam over the whole of the condenser tube area. The pear shape concentrates the tube surface at the point where the largest volume of steam is admitted where it is most needed.

There are four sets of gunmetal circulating pumps, two for the port and two for the starboard condensers, with 29-inch inlet pipes and driven by compound engines of Harland & Wolff's own make. For each condenser there are two sets of Weir's air pumps of the "dual" type, both air and water-barrels being 36 inches in diameter by 21 inches stroke.

For generating electric current, both for light and power, four 400-kilowatt engines and dynamos are fitted in a separate watertight compartment aft of the turbine room at tank-top level. The engines, which indicate each about 580 horsepower, are of the Allen vertical three-crank compound, enclosed forced lubrication type, running at 325 revolutions per minute. Each set has one high-pressure cylinder, 17 inches in diameter, and two low-pressure cylinders, each 20 inches in diameter, with a 13-inch stroke. They take steam at 185 pounds pressure per square inch. The engines exhaust either into a surface heater or to the condenser. Each engine is direct-coupled to a compound-wound, continuous-current dynamo, with an output of 100 volts and 4,000 amperes. Their collective capacity is 16,000 amperes. The dynamos are of the ten-pole type, and are fitted with inter-poles.

In addition to the four main generating sets there are two 30-kilowatt engines and dynamos, placed in a recess off the turbine room at saloon-deck level. Three sets can be supplied with steam from either of several boiler rooms, and will be available for emergency purposes. They are similar to the main sets, but the engines are of the two-crank type. The distribution of current is effected on the single-wire system, and is controlled and metered at a main switchboard placed on a gallery in the electric engine room, to which the main dynamo cables and feeders are connected. The latter pass up through port and starboard cable trunks to the various decks, radiating from thence to master switch and fuse boxes grouped at convenient points in the machinery spaces and accommodation, from whence run branches to the distribution fuse boxes scattered throughout the vessel controlling the lamps and motors.

A complete system of electric lighting is provided, and electricity is also largely employed for heating as well as for motive power, including seventy-five motor-driven "Sirocco" fans, from 55 inches to 20 inches in diameter, for ventilating all the passenger and crew spaces as well as the engine and boiler rooms. All the fan motors are provided with automatic and hand-speed regulation.

The shell plating of the ship is remarkably heavy. It is mostly of plates 6 feet wide and of about 30 feet in length. The width tapers towards the ends. The laps are treble-riveted, and the shell strakes in the way of the shelter and boat decks have been hydraulically riveted. Also the turn of the bilge, where bilge keels 25 inches deep are fitted for 295 feet of the length of the vessel amidships. There are fifteen transverse watertight bulkheads, extending from the double bottom to the upper deck at the forward end of the ship, and to the saloon deck at the after end far above the load water-line. The room in which the reciprocating engines are fitted is the largest of the watertight compartments, and is about 69 feet long; while the turbine room is 57 feet long. The boiler rooms are generally 57 feet long, with the exception of that nearest the reciprocating engine compartment. The holds are 50 feet long. Any two compartments may be flooded without in any way involving the safety of the ship. The two decks forming the superstructure of the ship and the navigating bridge are built to ensure a high degree of rigidity. At the sides they are supported on built-up frames, in line with the hull frames, but at wider intervals. The deck houses are specially stiffened by channel-section steel fitted in the framework, and where, as on the boat deck, the public rooms pierce the deck, heavy brackets are introduced to increase strength against racking stresses when the ship is steaming through a heavy seaway. Expansion joints are made in the superstructure above the bridge deck at convenient points in the length—one forward and one aft, the whole structure being completely severed and the joints suitably covered.

The stern-frame was made by the Darlington Forge Company, and the total weight of the casting was about 190 tons, the stern frame being 70 tons, the side propeller brackets 73¼ tons, and the forward boss-arms 45 tons. The center propeller, driven by the turbine, works in the usual stern-frame aperture, while the wing propellers are supported in brackets. The stern frame is of Siemens-Martin mild cast steel, of hollow or dish section, in two pieces, with large scraphs, one on the forward post and one on the after post, connected with best "Lowmoor" iron rivets, 2 inches in diameter, the total weight of rivets being over a ton. They were all turned and fitted and specially closed with rams. There are in all 59 rivets in the forward and 54 rivets in the after scraphs. In the stern frame there is the boss for the shaft driven by the turbine, the lower portion of this part of the stern frame having a large palm cast on its extreme forward end, to give a solid connection to the after boss-arms and main structure of the vessel.

The rudder also has been constructed by the Darlington Forge Company, Ltd., and is of the usual elliptical type, of solid cast steel, built in five sections, coupled together with bolts varying from 3½ inches to 2 inches in diameter. The top section of the rudder is of forged steel from a special ingot of the same quality as naval gun jackets. On the completion of the forging an inspection hole was bored through the stock of the rudder in order to ensure that there were no flaws.

There are ten decks in the ship, named from the bottom upwards: Lower orlop, orlop, lower, middle, upper, saloon shelter, bridge, promenade and boat. The passenger decks—promenade, bridge, shelter, saloon, upper, middle and lower—are named alphabetically A, B, C, D, E, F, G. Two of the decks are above the molded structure of the ship. The lower orlop, orlop and lower decks do not extend for the complete length of the structure, being interrupted for the machinery accommodation. The bridge deck extends for a length of 550 feet amidships, the forecastle and poop on the same level being respectively 128 feet and 106 feet long. The promenade and boat decks are also over 500 feet long. The first class passengers are accommodated on the five levels from the upper to the promenade decks. The second class passengers have their accommodation on the middle, upper and saloon decks,

and the third class passengers on the lower decks, forward and aft, and on the middle, upper and saloon decks aft.

The steering gear is fitted on the shelter deck, and is very massive, the diameter of the rudder stock—23½ inches—affording some idea of the dimensions. The gear is of Harland & Wolff's wheel-and-pinion type, working through a spring quadrant on the rudder head, with two independent engines, having triple cylinders, one on each side. Either engine suffices for the working of the gear, the other being a stand-by. The gear is controlled from the navigating bridge by telemotors and from the docking bridge aft by mechanical means.

The navigating appliances include, in addition to two compasses on the captain's bridge and one on the docking bridge aft, a standard compass on an isolated brass-work platform in the center of the ship, at a height of 12 feet above all iron work and 78 feet above the waterline. Adjacent to the bridge there are to be two electrically-driven sounding mchines, arranged with spars to enable soundings to be taken when the ship is going at a good speed.

The vessel is to be fitted with complete installation for receiving submarine signals. The lifeboats, which are 30 feet long, are mounted on special davits on the boat deck. The ship is designed for two masts, 205 feet above the average draft line, a height necessary to take the Marconi aerial wires, and to insure that these will be at least 50 feet above the top of the funnels and thus clear of the funnel gases. The masts are also for working the cargo by means of cargo spans, and in addition there is on the foremasts a derrick for lifting motor cars, which will be accommodated in one of the foreholds. There are three cargo hatches forward and three aft. All the hatches in the after part of the ship are served by electric cranes of the same make; two of these will be on the promenade deck; there being two small hatches to the hold below, so as to form a minimum of interference with the promenading space.

The first class passengers will be accommodated on the five levels from the upper to the promenade decks. The second class passengers have their accommodation on the middle, upper and saloon decks, and the third class passengers on the lower deck, forward and aft, and on the middle, upper and saloon decks aft. There are three elevators in the main companionway and one in the main second class companionway. For first class passengers there are thirty suite rooms on the bridge deck and thirty-nine on the shelter deck. These are so arranged that they can be let in groups to form suites including bedrooms, with baths, etc., with communicating doors. On each of these two decks, close to the companionways on either side, adjacent rooms are fitted up as sitting or dining room. In all there are nearly 330 first class rooms, and 100 of these are single-berth rooms. There is accommodation for over 750 first class passengers.

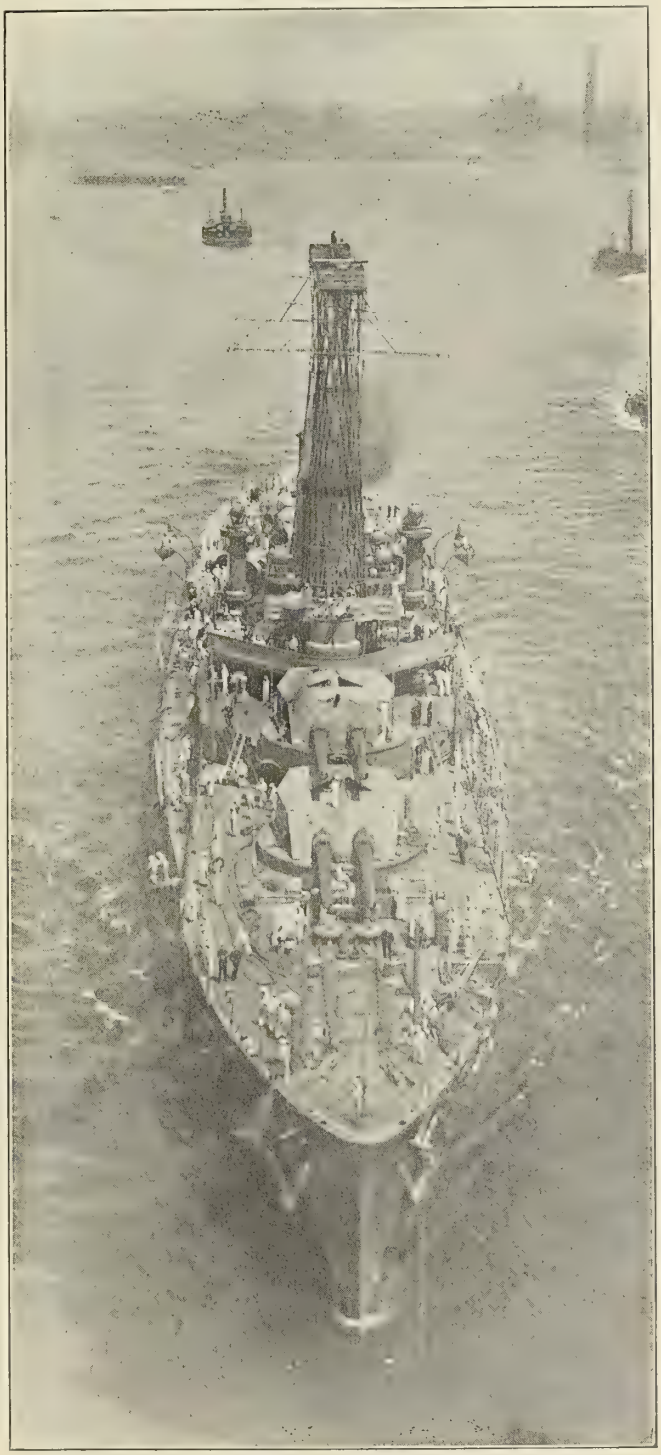
For second class passengers the rooms are arranged as two or four-berth rooms, the total number of second class passengers being over 550. For the third class passengers there is a large number of enclosed berths, there being 84 two-berth rooms. The total number of third class passengers provided for is over 1,100.

The first class promenades on the three top decks in the ship will be exceptionally fine. The bridge deck promenade is entirely enclosed. It is a space over 400 feet long, 13 feet minimum width each side of the vessel, and with a solid side screen fitted with large, square lowering windows. The deck above this is the principal promenade deck, and is entirely devoted to first class passengers. It is more than 500 feet long, and will form a splendid promenade, the width in parts exceeding 30 feet. The topmost, or boat deck, is also devoted to first class promenading, and is 200 feet long and the full width of the ship. The first class dining saloon is designed to accommodate 532 passengers, and ample smoke-room, restaurant, lounge and reading and writing room accommodation is also provided.

The second class dining saloon is situated on the saloon deck aft. It extends the full breadth of the vessel, with extra large opening pivoted sidelights arranged in pairs. The paneling of this room will be carried out in oak. The third class dining accommodation is situated amidships on the middle deck, and consists of two saloons well lighted with sidelights and will be finished enamel white.

Deck View of Battleship Delaware.

As the battleship *Delaware* was leaving New York harbor June 1 to cross the Atlantic to take part in the great Corona-



DECK VIEW OF THE U. S. BATTLESHIP DELAWARE.

tion naval review at Spithead, our photographer, Edwin Levick, of New York, photographed the ship as she was about to pass under the Brooklyn Bridge. A reproduction of his photograph is shown herewith.

FERRY STEAMER PUPUKE.

Steamer *Pupuke* has been built at Auckland, New Zealand, for the Tahapuna Tram & Ferry Company, to run from the city across the harbor to O'Neil's Point, where the passengers connect with the same company's tram service to Lake Tahapuna, one of New Zealand's pleasure resorts.

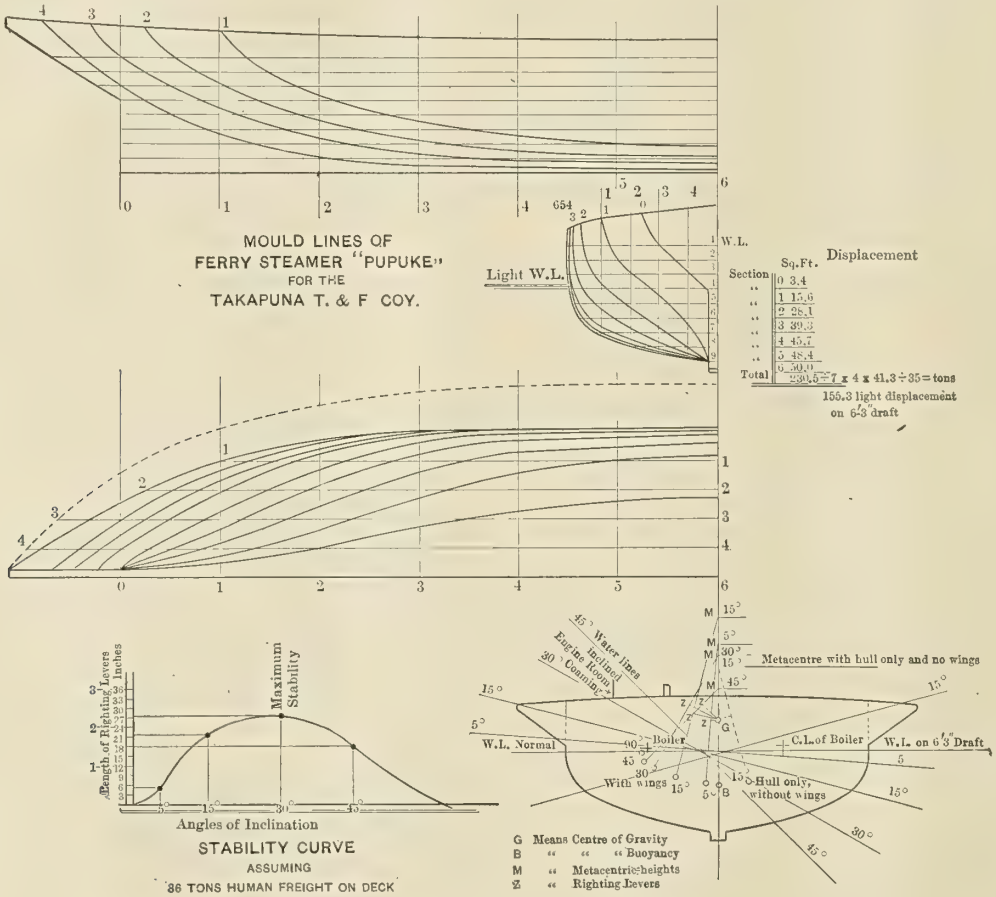
In making this trip the vessel has to cross the prevailing winds, which at times are very severe, and also across a tide of about three knots. For this reason the vessel was designed with the deck projecting on each side beyond the hull proper and then planked up and calked outside the struts so as to form airtight compartments, extending on both sides from the water line to the deck. By this means a very much larger passenger license was granted, the vessel took practically no more power to drive, and under bad weather conditions, when all the passengers accumulated on the lee side, the wings becoming submerged, moved over the center of buoyancy and increased the stability of the vessel. This feature was very noticeable when on one occasion the *Pupuke* took out about 500 passengers to witness some yacht races, when with passengers crowding to one side, both on upper and lower decks, the vessel only listed sufficiently to allow those behind to see over the people in front.

Another feature is the building up forward and aft of the superstructure to prevent the drafts usual on these vessels, caused by the vessel's progress. It has also proved itself beneficial in keeping off the spray in head-on weather. On the upper deck a matchlined bulwark is carried round fore and aft for the same reason. The hull itself is built on the diagonal principle, which, we believe, is peculiar to New Zealand,

THE NEW ZEALAND FERRY STEAMER PUPUKE.

for vessels up to about 150 feet in length, the reason being that the New Zealand kawri lumber is very suitable for this form of building. Believing this will interest wood shipbuilders, we will endeavor to describe the *modus operandi*, as follows:

After the keel has been laid, the garboard strake is laid up on each side, and edge bolted through from outside edge of one garboard to the other, the bolts passing through top of keel. Then assuming, as was the case in this ship, that the diagonal planking is to be two thicknesses of ⅞-inch planking, the floors are cut from hard wood and placed in position, leaving false blocks of 1¼-inch thickness between the floors and the keel, to be afterwards knocked out to allow the diagonals to pass through below the floors and over the keel.



LINES AND STABILITY CURVE OF THE PUPUKE.

Then having set up the temporary molds in position about 6 feet apart, the stringers are bent round the molds after being steamed and clamped up to the molds which, if of wood, are notched out to receive them, and the ends are secured to stem and stern posts.

The frame is then ready for the diagonals, which are 6 inches by 7/8 inch, they are steamed and quickly slid in between the keel and floors, and men on each side with clamps bend the diagonal right up to the deck line on each side and secure them to the stringers, the end of the diagonal on the port side rising at an angle of about 45 degrees from the keel and finishing at the deck line forward of amidships and the end on the starboard side rising aft of amidships, thereby forming a diagonal with the center line of the ship. This is continued as far up and forward as possible to insert between keel and floors, but when reaching the deadwoods the diagonals are cut and securely rabetted.

After laying this first diagonal the outside is coated with Stockholm tar and then the second diagonal is put on in the same way, but at the opposite angle; another coat of Stockholm tar, and on goes the fore and aft skin of 3 inches by 9 inches at the top of side, and on turn of bilge and intervening planking, 9 inches by 2½ inches. The hull is then thoroughly fastened with bolts and nuts, long ones through the stringers and short ones between, but through the diagonals. The keelsons having been put in can be then bolted through each floor and skin of ship, and, when the nuts are tightened, the keelsons, floors, diagonals and keel are all hove up good and sound. Bulkheads are then put in and secured, and the molds lifted out and the vessel sheathed, in this case with 5/8-inch Tobra (a New Zealand wood which resists the attack of worm), laid on felt. The result is a vessel that will stand a tremendous amount of wharf bumping and hard usage, and does not seem to be affected by being continually allowed to ground at the wharves.

The writer designed a vessel some years ago on this principle, and, up to this date, she is loaded three times a week with 200 tons of cement while resting on the bottom, and yet is absolutely watertight, as, of course, is necessary for the cement trade. There are vessels thirty years old still running in New Zealand waters which are built on this method and are sound yet.

The *Pupuke* is propelled with a compound surface condensing engine, having cylinders 13 inches and 26 inches by 18 inches stroke, with independent pumps and condensers and two boilers of the marine return tube type, with a working pressure of 130 pounds per square inch. Two boilers were fitted with a view to lowering the center of gravity and to allow the shaft to run between rather than under the boilers. The independent pumps and condenser were fitted with a view to getting away from the wharf with full speed, and to save fresh water from the dynamo at night while lying at the wharf.

The pumps are the writer's own design and have given good results in several vessels, the air, circulation, feed and bilge pumps being all worked from one cross-shaped crosshead by one cylinder operating through a piston rod into the center of the cross, and valve motion and eccentric motion being secured by return connecting rods to two small fly-wheels.

The vessel is well equipped with electric light from a Brush dynamo coupled direct to a Reader engine. The side lights and masthead lights are all electrically operated from the pilot houses. The passenger license is 774 passengers. The hull was built by Mr. George Niccol, shipbuilder, and the machinery by Messrs. George Fraser & Co. The electric lighting system was installed by Messrs. Fenn, and the hull and machinery built under the supervision of Mr. L. B. Harris, A. I. N A, the company's engineer

STEAMER SIOUX.

Steamer Sioux.

The steamer *Sioux* was built by the Moran Company, of Seattle, for the Puget Sound Navigation Company for service on the Seattle-Irondale-Port Townsend route.

She is a single-screw, steel passenger steamer, 150 feet long, propelled by a four-cylinder, triple-expansion engine, with independent auxiliaries. Steam is supplied by two Seabury water-tube boilers with equipment for burning fuel oil. The vessel has a speed of 15 knots, which is an unusual speed to be attained by a steamer of this size. The vessel is built entirely of steel. One of the novel features incorporated in the construction and arrangement of the hull and passenger accommodations is that the house on the upper deck is carried out to the sides of the ship with no space wasted in passageways on the outside of the house. The boat is fully equipped with dining saloon, smoking room, bar, etc., and is built in strict accordance with the United States Steamboat Inspection laws for ocean-going service.

PRACTICAL EXPERIENCES OF MARINE ENGINEERS.

Incidents Relating to the Design, Care and Handling of Marine Engines, Boilers and Auxiliaries; Breakdowns at Sea and Repairs.

Concrete in an Old Hull.

Referring to Mr. Stein's inquiry in the April number as to the advisability of substituting concrete for other ballast in his iron hull, we can assure him from our own experience that there is absolutely no question as to its advisability. If well done, with the concrete carried well up in her bilges and bound to the hull by means of old bolts run through angle-iron frames, the bottom plating can wear out and yet have a good boat under one's feet.

The writer has concreted the bottoms of four of his own boats, and if I were building a new ship of either iron or wood, irrespective of size, would concrete her bottom, not as we formerly covered her bilges with from ½ inch to 2 inches of cement to prevent corrosion where it was impractical to get at the scale and paint, which was the sole reason for its being done, but to add longitudinal strength to hull and lessen the liability of the bottom being pierced by rocks, should she be stranded on rocky bottom. I doubt if our marine architects realize the vast increased strength and resisting power to abnormal strains a hull of reinforced concrete possesses.

Permit me to cite some actual experiences in the use of this, to the writer's mind, highly valuable building material. About fifteen years ago I purchased an iron steamer whose bottom plating, originally thin, had, by continual crossing over sandy bars, become very thin and almost worn through. We could not afford to replace her bottom, so we experimented with reinforced concrete, placing it about 10 inches thick, carrying it well up above the turn of the bilges, gradually lessening its thickness as we got higher. Through the angle-iron frames we drilled ⅜-inch holes, into which round rods were rove, over all placing the concrete, and made as perfect a bond as possible. Our aim was, and we still consider it the best, to tie the concrete bottom to the upper part of the hull. We considered them as two separate units, the success of the operation depending largely upon their being tied securely together. The job far exceeded our expectations. Afterwards when her bottom had become entirely worn through in places we considered the concreted part the very strongest part of the ship.

Here at Honolulu the writer bought a small schooner, built for and used for freighting. She had about 15 tons of scrap iron ballast in her bilges, into which dirt had been collecting for years. We desired to convert her into a yacht, and to get rid of the odor from the bilges we removed the ballast and took the bottom ceiling out up to and above the turn of the bilges. Along the top of the frames we laid old railroad iron, about 12 inches apart, covering all with concrete about 18 inches thick on the bottom, diminishing to 4 inches above the turn of the bilge. Our object was attained, in so much that we never again were annoyed by bad smells from the bilges. Two years later this boat went ashore on sharp lava rocks upon which the sea beat at times very heavily, and which no ordinarily-constructed hull could have remained intact for twenty-four hours without being crumpled and broken up as a tin can would be had she been built of iron, or if built of wood splintered into matchwood, but upon investigation it was found that her bottom and sides as far as the reinforced concrete had extended were intact. The outside planking and frames were torn and splintered into bits by the pounding on these sharp rocks, which appeared to have no effect upon the concrete bottom. It was as if the outside planking and frame was simply a form, which it was a fact, and that it did figure so far as the structural strength was concerned, the lower half of her hull having the appearance of an old-fashioned wooden chopping dish, every other vestige of the boat having broken up and disappeared, remained intact for months.

This experience convinced me that in reinforced concrete we had a cheap, strong and durable material which could be used in construction of floating property to advantage to a larger extent than at present. I have two vessels now in commission with reinforced concreted bottoms. They can pound rocks until the seas sweep everything above the waterline, yet their bottoms will be all right. It is a well-known fact that when a ship is stranded it is not often that we fear damage to the upper part of the ship's hull, but the crumping up and piercing of her bottom. Some years ago the writer superintended the repairs of a steamer of 4,000 tons capacity. Reinforced concrete was in her in such shape that she is running to-day, and when she goes into the scrap heap it will not be from weakness of her bottom.

We have had for a long time under consideration the construction of a vessel whose hull would be entirely of reinforced concrete. Stranding and the teredo would have no terrors for us then. The question of weights, thickness of material and best type of reinforcement are well worth the earnest attention of the marine architect and engineers. The ordinary angle-iron without reverse bars but with longitudinal angle-irons riveted to the frames at close intervals forming a skeleton, like an old-fashioned hoopskirt, is the idea I have in mind. For barges, scows, floating derricks, sectional drydocks and the like, particularly if located where there are no dockage facilities, there is no question as to the advantage of using this material.

In Mr. Stein's case, where ballast is required, where the ship's bottom is corroded, there would be no mistake made in using reinforced concrete. He must use something for reinforcement—old iron rods, bolts, bars, etc., the longer the better for this work. We have used condemned railroad iron and found it well suited. A heavy mesh wire is very good. The prime feature is to see that it is well secured to the frame of the ship.

We will be interested to hear from other readers as to their experiences with concrete in this line. Fred. C. Miller.

Honolulu, T. H.

A Burst Condenser.

The walls of a surface condenser are subjected to an external pressure, due to the vacuum. The cast iron walls are stronger to an external pressure than to the internal pressure when, as in most cases, the stiffening ribs are cast on the outside of a condenser. From without the condenser is subjected to a compression stress and from within to a tensile stress. The compressive strength of cast iron is greater than its tensile stress. Therefore, the ribs on the outside of the condenser make it stronger to an outside than to an inside pressure. The same is true of the flat-valve chest cover. The stiffening ribs should never be placed on the outside for the above reasons, but this is often forgotten.

It is possible when the cylinder drains are led to the condenser that the pressure in it can become too high when the

engine is warmed up. When the air pump is of the common type, with foot buckets and top valves, there is no danger, as these valves will lift, so that the excessive pressure is relieved. But when an Edwards patent air pump is provided there are not foot and bucket valves, as the air-pump piston covers the ports in the lines, the vapor cannot escape and the pressure may become so high that the large flat surface condenser cannot stand it, and burst. It is, therefore, necessary to have safety valves on the condenser, or on the under side of

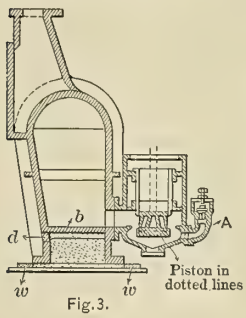


Fig. 3.

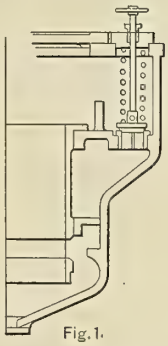


Fig. 1.

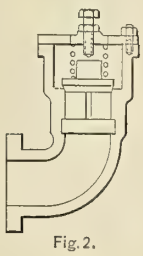


Fig. 2.

the air pump. In Figs. 1 and 2 such valves are shown. When the engine is started the water will lodge in the base of the pump and condenser. If the engine is started too quickly then water cannot easily escape, unless the safety valves have been fitted. In Fig. 1, no water is wasted when the valve lifts, but its action cannot be seen and it is not known if the valve performs its duty or not. In Fig. 2 some fresh water is lost, but the action of the valve can be seen and controlled. When these valves get to leaking, the latter arrangement of valve allows them to be easily repaired, and it is necessary to do this at once or the vacuum will drop. The valve in Fig. 1 will pass some water when leaking, but it will not affect the vacuum.

In starting the tug *M. B.* a sharp knock was heard, and it was impossible to get a good vacuum. On looking for the cause it was seen that water was running from the base of the condenser, showing that something must be cracked. On investigation it appeared that the engineer in charge did not understand the use of the valve, as in Fig. 2, and thought it a pity to lose fresh water, so he turned on the screw of the valve to prevent the waste and the trapped water cracked the condenser's bottom. A new condenser was too expensive for the owner; therefore, something else had to be considered and the following was resorted to: Along the length of the condenser some 1½-inch holes were drilled just under the bottom, on both sides. Wood pieces, Fig. 3 W, were placed all around the bottom flange. Then the whole base was filled with Portland cement. In a few days the cement set and dried thoroughly, and the engine was started and the repair showed that the method was quite satisfactory, as the vacuum could be held, and the condenser never afterwards gave any trouble.

Rotterdam. K. D.

Experiment with Retaining Pins.

In contributing one's experience to magazines that are to be read and discussed by the "salt water fraternity" one has to rely on personal experiences. I submit some few remarks on a difficulty that we once in a while meet, which has to be made good quickly when one is on a lee shore or in shifty currents.

In the instance I refer to the engineer of the ship was a long-legged—yes, and a long-headed party. I was about twenty-fifth assistant engineer at the time, and in making my oiling rounds, soon after going on watch, I detected a slight thud or pound in the low-pressure crank pin, which had previously been running cool and smooth, and, on feeling it, I found it had warmed up considerably, and I also took a nick out of my forefinger in feeling it. Either the jamb nuts had been left loose or the bolts had not been driven up tight, which is usually the case. Anyway, the crank-pin nuts slackened away while we were running, causing the shims and heavy

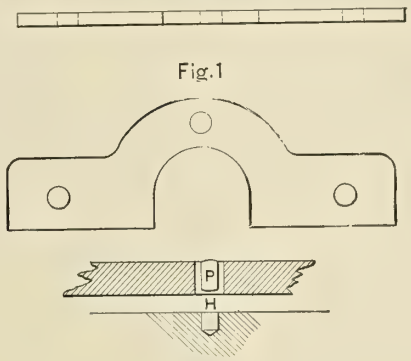


Fig. 1

Fig. 2

parting piece to flop up and down to the music of the thumping of the crank pin, which was making a rapidly-increasing noise. During the time it took me to think it over and to consider whether to stop and cinch up, the parting pieces, three in number, took advantage of my deliberation to shake loose from the bottom half brasses. As the retaining pins were not screwed in and had worked up into the shims and parting pieces, leaving nothing to hold them, they said "good-bye" and jumped out, striking a heavy, glancing blow on the condenser and landing in the crank-pit, all of which happened in a very few seconds, or parts of a second. Of course, the engine was immediately stopped, and I "ducked." After a survey was held and I got my hair to lie down again, I showed up with a big spanner and "butting-sack," and all there was to do was to take up on the pin just the way she was, hammer all up tight, leaving out the parting pieces altogether, and all this operation took about five minutes.

The remaining run to port was made in thirty to forty minutes. We arrived nearly on schedule time, where new shims and parting pieces were put in ready for the return trip. The attached sketches give an idea of the shims, and Fig. 1, and how the pin *P* worked out of the hole *H*, which is in the lower brace, as shown in Fig. 2. Now the moral of my story is: Have these retaining pins screwed in.

Winthrop, Mass. H. A. L.

A boiler plant waste meter is an instrument which comprises a number of important improvements over older instruments for increasing boiler plant economy. This invention is described as follows: Ordinarily CO_2 recorders work by sampling bells and the measurement of the volume of a sample of gas before and after the abstraction of CO_2. The Uehling waste meter operates on a distinctly different principle; *i. e.,* measurement by partial vacuum between the two apertures. Thus continuous charts are obtained on the recording gages, which can be placed at any distance from the machine proper (being connected to it simply by copper tubing); and, furthermore, simple indicators can be used connected to the instrument in the same way. Again, as the principle of vacuum measurement is used in the Uehling waste meter for measuring temperature as well as CO_2, all the information desired regarding waste gases going up the stack is obtained in the machine.

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Electricity for Marine Work.

We publish in this issue several articles which bring well down to date what has been accomplished during the past quarter of a century in the uses of electricity in the marine field, and they give a glimpse as to the great possibilities of the future of this wonderful power. Probably in no one field are the conveniences and advantages of electricity more evident than in the marine field. The dark holds aboard ship are easily made as light as day; stuffy quarters can be cooled and heated; darkness can be turned to light in an instant, and the whereabouts of the poor fellow who has fallen overboard located. A new language has sprung up, which, to the ears of an engineer of scarcely more than twenty-five years ago, would be senseless babble, and yet to-day we do not know any more as to what this wonderful force is than was known generations ago. Fortunately, however, we know how to generate the force, and how to properly harness it for its many uses. In our articles we show the many uses of electricity, not only for power, heating and lighting, but in its latest development—that of wireless telegraphy. Almost as important uses are shown in yards where vessels are built and repaired, and last, but by no means least, is the possibility of using this wonderful force as a prime mover for vessels of large sizes. It will thus be seen that electricity not only greatly adds to the convenience of the shipbuilder and those who operate the ships, but especially to the convenience and comfort of passengers, and vessels equipped with wireless telegraph are put in instant communication with all corners of the globe. All of these wonderful developments of the past twenty-five years lead us to speculate as to what may be the marvelous developments of the next twenty-five years.

Economical Handling of Freight.

The several communications published in another column give marked evidence that the article in our June issue regarding the economical handling of freight touched upon an important point. The only way to bring about any improvement in this important part of marine work is for the designers and builders of ships to work in harmony with those people who handle the freight at the shore end, and, judging by many private letters received, in addition to those published, there is a desire to bring about this conjunction of interests. The economical handling of freight seems to us, perhaps, the most important question from a financial point of view that is before the marine interests to-day, and we sincerely hope that those of our readers who have not already given this subject careful consideration will turn back to our June issue and note the points made by Mr. Harding and offer any further suggestions which may tend to bring about the much-needed improvements.

Use of Concrete on Board Ship.

In previous issues we have called attention several times to the uses of concrete in building vessels. In this issue we print a letter from Honolulu which tells of an unusual use of concrete in giving new life to old and wornout hulls. The great value of the letter lies in the fact that it does not deal with experiments, but with practical commercial results. It demonstrates that concrete is thoroughly reliable for repairs, and that by its use practically new hulls can be made out of old ones. We all know that concrete has for years been used to some extent in ships' bottoms advantageously. Evidently success in using this material depends upon the proper use of metal binding, wire-mesh, bars, rods, etc. There are many old vessels, no doubt, which could be saved from the scrap pile by the judicious use of this material. It has in its favor cheapness, reliability and permanency; it can be applied at any place with tools that can be carried with ease and obtained in any port; no great skill is required in using it, and it improves with age, which cannot be said of other materials.

THE ECONOMICAL HANDLING OF FREIGHT.

The article published on page 237 of our June issue on the "Design and Construction of Freight Steamships from the Cargo Transferring Standpoint," has brought forth a great many communications from our readers. Unfortunately, most of them are not intended for publication. Following are a few which we have been permitted to print. There are many important points still to be brought out in this discussion, and we shall hope in a future issue to publish further discussion:

Editor International Marine Engineering:

The article by Mr. H. McL. Harding on the importance of arrangement for freight handling in the designing of cargo steamers is most interesting and absolutely true.

The trouble, so far as I see it, is that it is not to the shipbuilder's interest to spare sufficient time in developing a new construction, the results of which he must guarantee. If he builds something which has been proved successful in the past he escapes possible future trouble. Usually our freight steamers, or, in fact, all our steamers, are built by the oldest captain and engineer of the line putting their heads together with some favored shipbuilder, with the results mentioned by Mr. Harding. Of course, somebody has got to pay for the work of developing a new design, and the natural person to pay for this is the one who is going to most directly benefit; that is, the ship owner. Until he can see this, and is willing to spend the money to have such a design prepared, I do not think we can expect much relief. Clinton H. Crane

Editor International Marine Engineering:

The defects in design of freight steamships referred to by Mr. Harding in his articles in your June issue are mostly due to unknown conditions at the time the vessel was built, and, unfortunately, he compares vessels designed for straight-bulk cargoes to be delivered always at one point with vessels designed for general freighting business where the materials to be loaded or unloaded are unknown either as to quantity, weight or destination.

Mr. Harding cites, as defects in design, the building of officers' quarters, kitchen, mess room and even store rooms over the whole central portion of the vessel, thus greatly increasing the difficulty of reaching the cargo between decks. In this case he condemns what may be classed as the almost universal type of modern freight steamships for general ocean service. Let us see how far this condemnation is justified. For general service the type of cargo steamer with engines in the stern was long ago abandoned on account of the difficulty of trimming with cargoes of varied specific gravities. These conditions are not present in the special service required of freight vessels on the Great Lakes. The placing of the engines in the center of the ship is now the almost universal practice for ocean carriers, except in the case of carrying oil in bulk, when the conditions become similar to those affecting the Great Lakes traffic. The bridge deck, then, became the natural type, and in ordinary freight vessels the length of the bridge deck is little more than that of the space occupied by the engines, boilers and coal bunkers, and in nowise interferes with the handling of freight through the hatches. The space under the bridge deck thus becomes the most suitable for accommodating the officers and crew.

Mr. Harding advocates larger side cargo ports where side ports are used, and with only the handling of the cargo to consider the larger they are the better they will answer their purpose. The classification societies, however, are very particular, and properly so, in regard to side ports, admitting them only when full compensation has been provided for the material cut away. They are of great use in coasting steamers, especially those whose service includes passengers as well as freight. For general freighting business and only long-distance transportation, with facilities to handle freight of the most varied character, all handled by the appliances on the ship, I do not see how much improvement could be made on the ships of the American Hawaiian Steamship Company. The horizontal moving of freight between decks is a difficult problem, and many devices have been tried to reduce the labor. General freight cannot be piled to any great height, consequently the 'tween decks becomes a necessity, and whenever a vessel can be designed to carry bulk cargo that can be piled to any height, then the special ship, as we have on the Lakes, appears. If to this is added a definite point of loading and discharging, where special machinery can be installed on land, then the conditions are perfect for a design of ship that will offer the least resistance to being filled or emptied of the material she is designed to carry; but where the character of the cargo is unknown, and the points where it is to be loaded or discharged equally unknown, then the ship must be of a general type, the result of many compromises, not the best that could be designed for any fixed conditions, but the kind of ship that will meet all conditions fairly well in a general way, beside being entirely independent of all special shore cargo-handling machinery. The great bulk of general ocean transportation is effected on such ships.

Hatches are being made larger as the size of vessels increases, and if the height between decks could be made about 10 feet electric travelers could be installed for horizontal movement to the hatches, all of which has been a matter of much thought on the part of both owners and builders. Steady progress is being made towards more economical handling of freight on ship board. The sorting of freight as it comes from the ship, especially those engaged in the coasting trade —and I am thinking just now of the Pacific Coast, where freight is received up to the hour of sailing and from many consignees—involves much costly handling. Often a lot of packages, delivered on the side of the dock in one lot from the cargo boom, will have to be divided and trucked to four or five different locations on the wharf. This is unavoidable in a general coastwise freighting business.

I have wondered if two-storied sheds on the wharves, with the outgoing freight arranged on the lower or wharf level and the incoming freight on the upper floor, would not be the better plan—both floors being served by a system of overhead travelers. If space were available at the land end of these sheds, teams and cars could be unloaded by arranging the system of travelers to extend over the railroad tracks and roadway, thus doing away with all hand-work and arranging outgoing freight so as to be readily reached by the ship's hoisting gear, and taking the incoming freight as it is landed on the upper floor, and either stowing it ready for delivery or carrying it direct to the teams or cars outside. Such an arrangement leaves the whole wharf space, both above and below, available for sorting and stowing freight. Such a scheme is already partly in use at many places, and given the necessary space and the proper design of wharf sheds, the cost of handling freight and the time consumed can be materially reduced. The problem as applied to general freighting is a difficult one, and progress will be slow in the future as it has been in the past. George W. Dickie.

San Francisco.

Editor International Marine Engineering:

I have read with considerable interest what Mr. Harding has to say on the handling of freight. The article criticises somewhat severely the present method of handling freight in coastwise cargo steamers. As fast as terminal facilities are brought up to date there is no question but that the shipbuilder will be able to adapt the ship to the improved condi-

tions, but as long as side ports are placed in new and improved vessels, absolutely regardless of the structural requirements of the ship and merely to suit some old wharf, it is hardly possible for the shipbuilder to do very much.

In connection with side ports taking the cargo from holds and 'tween decks, instead of the same going directly up through the ship and being transferred horizontally by overhead hoisting arrangements, as soon as such hoisting arrangements are in general use, trunk hatchways through passenger accommodation can always be arranged for. I would call attention to the fact that bulk carriers in the coastwise trade are all being built to suit modern handling facilities, such as coal and ore carriers. The writer of your article quotes Lake steamers as having clear decks amidships with no obstruction. These Lake steamers to which he refers are mostly in the bulk-carrying business, with machinery aft. This location for machinery is not advisable in general freight steamers, because questions of trim will come in, and if the vessel carries passengers may be serious enough to cause considerable discomfort. It should also be borne in mind that the Lake vessels can be very long, relative to their depth, owing to the smaller stresses set up by the motion of the water in the Great Lakes, as compared with that of the ocean.

Mr. Harding remarks that crews' quarters should be at the ends of the vessel, and clear decks amidships to avoid blind hatches. There is no reason why, in freight steamers, with machinery amidships, the crew's quarters should not all be in a double-story house on the weather deck. They will thus be in the most comfortable part of the ship, and at the same time get the benefit of all the air and light that can be obtained. As regards hatches, there is no reason why the whole upper deck along the center line should not be open hatchway, with just enough space between for winches and masts. Large hatches are coming more and more to the front in every design that is gotten out. When comparing the costs between manual and machine-handled freights, as is done by the writer in this article, some figures should be included showing the additional first cost of the machinery when making the comparison with manual labor.

In general, Mr. Harding's article presents a very interesting resumé of cargo-handling questions, but it should be borne in mind that the shipbuilder cannot go ahead of the terminal facilities. Naval Architect.

Philadelphia.

Editor International Marine Engineering:

The numerous articles that have been written by Mr. Harding and others on the mechanical handling of freight at terminals will undoubtedly result in some improvements, as these writers have put forth some very good ideas that must cause those in the business of handling freight to give some consideration and renewed activity.

Your article, and most others on this subject, have dealt mostly with generalities, and have neglected the small details involved which add so much to the cost. Vessels engaged in the transportation of ore and coal on which such remarkably low cost for transferring has been achieved receive their cargo by gravity and discharge it in uniform units by the use of grab buckets, and this material is discharged into a vehicle easily and quickly placed to receive it and easily and quickly removed. A vessel arriving at a pier with a miscellaneous cargo of, say, 2,000 tons cannot discharge its cargo by means of a grab-bucket, but almost every individual article must have a sling placed around it to receive the hoist hook. It is the placing of this sling around the packages that requires such a large force of men in the hold of a vessel and which brings up the cost of removal. The package is hoisted onto the pier at practically the same cost as a grab-bucket transfers its load. The 2,000 tons of cargo removed will necessitate the use of about 1,000 trucks to take it away from the pier on which it is unloaded, as the trucks will not average more than two tons each, whereas a coal or ore car will carry 50 tons. If these 1,000 trucks could be placed on the pier as easily and quickly as the coal or ore car can be placed to receive its freight, the vessel could place its cargo into the truck almost as cheaply as the grab-bucket places its load in the coal car. It is not possible, however, to accomplish this desirable condition, and therefore of necessity a considerable amount of the freight must be stored in piles on the piers, which means that after being deposited by the ship's machinery it must be moved to some other point on the pier where there is room to store it. This feature adds another heavy cost to the problem of delivery.

No doubt considerable saving could be accomplished by enlarged hatches on freight steamers, but to accomplish what Mr. Harding points out would require that the hatches be very much larger than the enormous hatches on Lake steamers. On the latter type of vessel the material is of a character that it will flow by gravity to a point where the grab-bucket can reach it. In the present state of the art of shipbuilding it is necessary to use some of the area of the deck, particularly amidships, in which to place the material necessary to give a vessel sufficient longitudinal and transverse strength to pass through heavy seas, and whatever area is allowed for this purpose will of necessity require some of the freight to be dragged in the hold, as Mr. Harding points out. This feature, while objectionable, adds very little to the cost of hoisting.

The serious problems to overcome are: First, to provide some method by which packages can be picked up by hoisting machinery in an economical way without injury to the packages, and, second, avoid storage and transference on the pier. Anyone who investigates this subject thoroughly will find that these two features, together with the classification involved, amount in cost to about 80 percent of the cost of delivering or receiving freight from the steamer's hold. These features, yet involved, would seem to be the ones to attack. F. L. Du Bosque.

Jersey City.

Editor International Marine Engineering:

The article by Mr. Harding in your June issue brings up a subject of great economical importance. It is self-evident that to remove a ton of freight vertically less power is required than to move it horizontally; that is, under conditions which are to be found aboard ship in its loading and unloading. It is conceivable that this might not be true in all cases, but in plain, everyday practice the statement stands.

In his description of a vessel especially designed with this idea of vertical hoist in view, the cost of removing cargo was cut from about 39 cents to 21 cents per ton. This is certainly a very satisfactory showing; but a further saving will be shown after the appliances and conditions are better understood. Marine men wisely look first to safety in ships. Valuable lives and cargoes are to be transported safely. While conservatism is commendable in the naval architect, has he not somewhat lagged behind in recognizing the great advance made during the last few years in the quality of material used in ships and the gain which is to be found in better forms in which the material can be secured? We certainly now have material which is of far greater strength than that obtained thirty years ago, and this is to be found in almost infinite variety of forms and weights, yet there is a clinging to designs which could be most advantageously changed, merely because they seem to have become recognized as satisfactory and are not changed from lack of boldness.

We must not, however, lay all this conservatism to the engineer or naval architect, or to those who handle ships. The constructors are seriously handicapped by classification

societies as well as by the marine insurance companies. It is quite natural that those who write insurance base their rates on past experiences, and are not likely to be blamed for a desire to stick to that which they know of rather than to fly to that they know not of. A vessel is built with a view to obtaining fair returns on the money invested, and an increase of insurance is a serious matter. Yet the saving which apparently can be effected by more carefully considering freight handling, both as to its actual cost and a lessening of breakage, it seems, would place the shipping people in a position where, at worst, they could pay more for insurance if the increased facilities in handling freight brought into question the strength of the ship. When one looks at the very small proportion of hatch space it becomes apparent that the vertical lift, which we must admit costs less than the horizontal push and pull, is only applicable to a very small percentage of the cargo space. To obtain a vertical lift for the entire cargo is, of course, impossible. In one vessel, built expressly for economical handling of freight, only 68 square feet of hatchway was provided, which was about 1½ percent only of the entire cargo floor space of a single deck. Now there is no doubt but what a vessel could be designed with a very much greater hatch space than 1¼ percent. In fact, the very vessel referred to could by slight alterations be made to have 25 percent instead of 1½ of the cargo hatches.

The Lake steamers are constantly referred to as examples of the advantage of large hatches; but, of course, the cargoes of these vessels is stable, and never miscellaneous, and there is no fair comparison between a Lake ore-carrying freighter and an ocean-going freight-carrying steamer. Vessels have been built for ore-carrying across the Atlantic that have very large hatch proportions, and they have proved satisfactory except in one case, where the load was injudiciously distributed, and, of course, it is utterly beyond the naval architect's power to build a vessel which, if improperly loaded, will not, to a certain extent, be damaged. Where the composite vessel is to be considered, that is, freight and passenger, the inevitable engineering compromise has to be met. But it will not be many years before the freight and passenger traffic at sea will be as clearly divided as are the same traffics on shore.

It is difficult to get an expression from those actually employed in loading and unloading vessels, as what they say would be looked upon as a criticism of their superiors. The boat men say that the subject belongs to the naval architect and shipbuilder, and architect and shipbuilder in turn seem inclined to believe that to take the line of least resistance is best and to provide simply what is asked for rather than suggest something new. But it does strike one as absurd in a day when labor has become so expensive that we continue to place the cargo in a vessel practically as it has always been done in the past. The danger to the stevedore is an item, and it is not an imaginary one. Maiming or killing men must result in financial loss, and by a system of a direct hoist the danger of men being maimed would be considerably diminished and a corresponding decrease in expense follow.

It would seem that the shipping world has been content to push, haul and pull with main strength and awkwardness the cargoes of the ships, and that it is pretty nearly time that a change be made. W. D. Forbes.

New London.

Editor International Marine Engineering:

Mr. Harding says "by the latest methods the freight can be taken from the holds to cars, to warehouses, or to any portion of remote sheds without rehandling." A complete description of the "latest methods" would be exceedingly interesting and instructive. The writer does not know of any modern installation where this flexibility can be attained without rehandling, in any such capacities as are required in discharging or in loading an ocean steamship. In fact, it is my belief, after a comprehensive study of existing conditions, that the successful handling of miscellaneous package freight demands that *it shall be rehandled* on account of sorting, classifying and properly collecting and distributing the packages, unless all of it goes directly from ship to railroad cars, or vice versa. The port of Hamburg, Germany, has a large and modern equipment for unloading steamships, consisting of batteries of revolving cranes, which hoist the freight from the hold and deposit it on the dock or on cars—all freight deposited on the dock must of necessity be rehandled.

It would not be difficult to design a perfectly flexible system for loading, unloading, conveying and distributing freight in almost any manner desired without rehandling for a very small or limited capacity, employing only a few units, but for such capacities as would be required for handling ocean freight the arrangement becomes so complicated and the number of units so great that interference and confusion is the result. While I do not advocate the rehandling of freight as a general proposition, I do believe in rehandling it as a necessary evil in order to attain the desired results. Rehandling of freight when done in connection with a mechanical system does not spell the additional expense and congestion involved in rehandling in connection with the manual labor method. We must learn to distinguish between rehandling in conjunction with mechanical conveying and rehandling in connection with manual labor.

For the loading and discharging of ocean vessels we can do no better than follow the general scheme of handling coal and ore on the Great Lakes. The same principles can be applied in the same way with the necessary detailed modifications to suit the material handled.

For loading vessels the ore is brought to the dock from all directions in railroad cars and dumped into a storage bin alongside the vessel. The railroad cars may be considered as units of a conveying system, each coming from a different place, but all of them finally assembling on the dock and transferring their loads, not directly to the ship, but to the dock. The reason for this is that the entire cargo can be assembled on the dock ready to be loaded into the vessel in the shortest possible time. The ore is now rehandled; that is, other means are employed for putting it into the vessel. True, this consists only in opening the gates of the bins by machinery and allowing the ore to run into the vessel by gravity. However, the cars could have been dumped directly into the vessel, and it is often done this way, both in the case of coal and ore, but the process requires much more time, hence rehandling is resorted to without material increased cost for loading the vessel rapidly and efficiently.

Package freight should be handled in much the same manner. It should be brought to the piers in railroad cars and drays, and unloaded within range of the vessel-loading machinery if conditions permit, otherwise it may be unloaded by mechanical conveyors, which will bring it as well as freight from various parts of the pier shed, or warehouses within range of the vessel-loading machinery to which it will be transferred (rehandled) and put into the vessel at the maximum rate of speed. In order that the vessel-loading and unloading machinery should work at maximum speed and efficiency, its duty should be limited to transferring freight between vessel and pier, or cars or conveyors on pier which would collect or distribute the freight to distant points.

For the mechanical handling of freight there will not be required any new types of machines—it is rather a matter of applying well-known and well-tried devices to the handling of freight, and designing an entirely new and suitable type of steamship pier to accommodate such machinery, and also improving the design and construction of steamships to make their holds more accessible. M. B. Waterman,

Progress of Naval Vessels.

The Bureau of Construction and Repair, Navy Department, reports the following percentages of completion of vessels for the United States navy:

BATTLESHIPS.

	Tons.	Knots.		May 1.	June 1.
Florida	20,000	20¾	Navy Yard, New York.....	92.7	93.4
Utah	20,000	20¾	New York Shipbuilding Co..	98.0	98.3
Arkansas ...	26,000	20½	New York Shipbuilding Co..	64.7	66.2
Wyoming ..	26,000	20½	Wm. Cramp & Sons.....	61-5	65.6
Texas	27,000	21	Newp't News Shipbuilding Co.	9.3	13.5
New York...	27,000	21	Navy Yard, New York.....	0.0	0.4

TORPEDO-BOAT DESTROYERS.

Mayrant	742	29½	Wm. Cramp & Sons.....	96.5	99.4
Monaghan ..	742	29½	Newp't News Shipbuilding Co.	91.5	98.1
Walke	742	29½	Fore River Shipbuilding Co..	97.8	98.5
Ammen	742	29½	New York Shipbuilding Co..	99.2	100.0
Patterson ...	742	29½	Wm. Cramp & Sons.....	78.3	82.3
Fanning	742	29½	Newp't News Shipbuilding Co.	15.3	21.5
Jarvis	742	29½	New York Shipbuilding Co..	8.7	10.4
Henley	742	29½	Fore River Shipbuilding Co..	10.0	10.9
Beale	742	29½	Wm. Cramp & Sons.....	11.8	22.7
Jarrett	742	29½	Bath Iron Works.....	19.6	31.2
Jenkins	742	29½	Bath Iron Works.....	17.9	26.9

SUBMARINE TORPEDO BOATS.

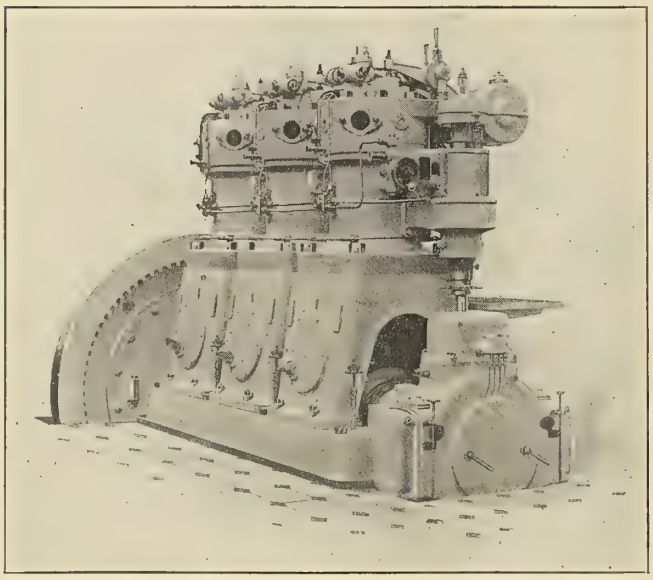
Seal	...	..	Newp't News Shipbuilding Co.	86.2	87.1
Carp	...	..	Union Iron Works.....	87.7	89.7
Barracuda ..	...	..	Union Iron Works.....	87.9	89.6
Pickerel	...	..	The Moran Co.....	84.2	84.6
Skate	...	..	The Moran Co.....	84.4	84.5
Skipjack	...	..	Fore River Shipbuilding Co..	85.8	91.1
Sturgeon ...	...	..	Fore River Shipbuilding Co..	85.0	89.5
Tuna.....	...	..	Newp't News Shipbuilding Co.	73.1	74.0
Thrasher ...	...	..	Wm. Cramp & Sons.....	38.8	41.5
Seawolf	...	..	Union Iron Works.....	23.8	31.2
Nautilus	...	..	Union Iron Works.....	23.8	31.2
Garfish	...	..	The Moran Co.....	21.8	27.9
Turbot	...	..	Lake T. B. Co.....	11.5	16.0

ENGINEERING SPECIALTIES.

Diesel Engines for Auxiliary Purposes.

The auxiliary most frequently used on board ship is that which generates electric current, and for this use the Diesel engine is most applicable. In ships where oil is used as fuel the same class of oil can be used for Diesel engines.

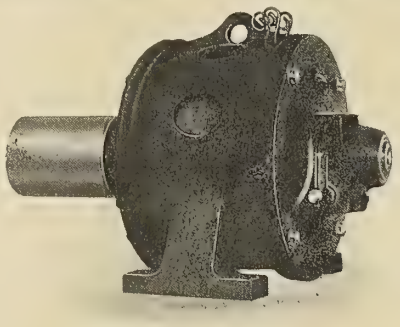
The Diesel Engine Company, Ltd., 179 Queen Victoria street, London, E. C., has brought out a high-speed multi-cylinder type of engine from 5 horsepower up. Every care has been taken to reduce weight yet maintain solidity, and



the balancing is such as to reduce vibration to a minimum. The arrangement for the supply of lubricating oil and cooling water is based on years of experience. The oil injected in the cylinder is ignited without the aid of any special apparatus. The compression of the air drawn into the cylinder is carried so far that the temperature reached thereby is sufficient to ignite and burn the spray of oil, and it is especially to be remarked that the pressure during the cycle does not exceed the compression pressure, whether the engine be working on the two or four-stroke principle. Great care has been taken in the selection of suitable material for the construction of the engines. The crank-shaft, of Siemens-Martins steel, is bedded in the bearings, lined with white metal, and to these the cylinders are rigidly secured by means of steel columns. The liners are made of close-grain cast iron, and the valves, which are all placed in the cylinder cover, are also cast iron, seated in removable seatings. A sensitive governor controls the fuel supply to the engine, and admits to the cylinder only the quantity which is required at the very moment.

Electric Motors for Shipyard Tools.

Messrs. T. W. Broadbent, Ltd., of Victoria Electrical Works, Huddersfield, are makers of complete electrical equipments suitable for shipyards and other work of a like nature. They have placed on the market a line of three-phase generators, delivering from 6 kilowatts at 750 revolutions per



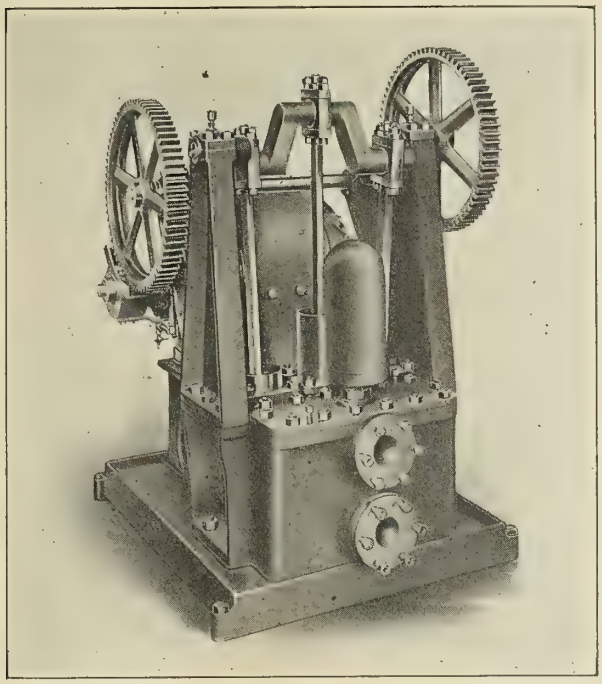
minute up to 250 kilowatts at 375 revolutions per minute. They are of the rotating field type, with laminated magnet cores and poles and cast iron central yoke. The stators are borne on planed seatings on the bedplate. The stator is of the slotted type, with partly open slots, and the winding is very effectively ventilated. Each machine is excited from a small continuous-current machine, which is carried on an extension of the bedplate. They are built for a power factor of 85 percent, the rise of pressure, with fixed position of the field regulator, from full load to no load not exceeding 18 percent, and the rise of pressure on a lighting load only being 4 or 5 percent. The fly-wheel effect of the heavy rotors of the dynamos being driven at a high speed is very effective in keeping both voltage and frequency constant.

All motors are wound with wire and insulating materials that are unaffected by heat, therefore standing very large overloads. The rotor bars are electrically connected to the short-circuiting rings, and mechanically expanded after being driven into the holes in the short-circuiting rings, obviating the use of solder. All ratings of motors are conservative and are guaranteed to give larger overloads than usual.

Davidson Electrically Operated Triplex Pump.

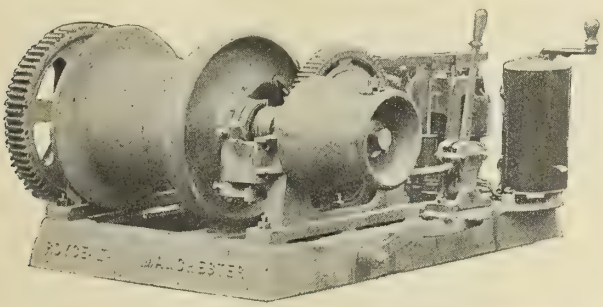
The M. T. Davidson Company, of 154 Nassau street, New York, U. S. A., is making an electric-driven pump for ship use. It is of the triplex direct-drive type and has been supplied to some of the later naval ships of the United States. These pumps are used principally for fresh-water service, maintaining the required pressure automatically by the usual method of electric control. Our illustration shows a very compact pump, the position of the motor being such as to occupy space, practically, within the outside dimensions of the pump itself. It is thus self-contained, requiring no expensive

foundation. Three single-acting plungers of bronze or steel, working through deep stuffing-boxes, give ample bearing surface and prevent leaking. The crank-shaft, as well as the connecting rods, are of steel, the main bearings being babbitted and the rod ends fitted with half brasses. The gears are cast iron, accurately cut, and are usually provided with cases. The driving pinion on the motor shaft can be made of rawhide for quiet operation if desired.



Shipyard Winches and Capstans.

Messrs. Royce, Ltd., Trafford Park, Manchester, build a motor-driven winch which is a very compact design, the barrel, gear, motor, and control gear being all contained on a single cast iron bedplate. The barrel is arranged to run free on the shaft and is connected thereto by means of a clutch controlled by a hand lever. It is provided with a band brake, operated by a foot lever, so that it may be disconnected from the rest of the gear and loads lowered rapidly on the brake.

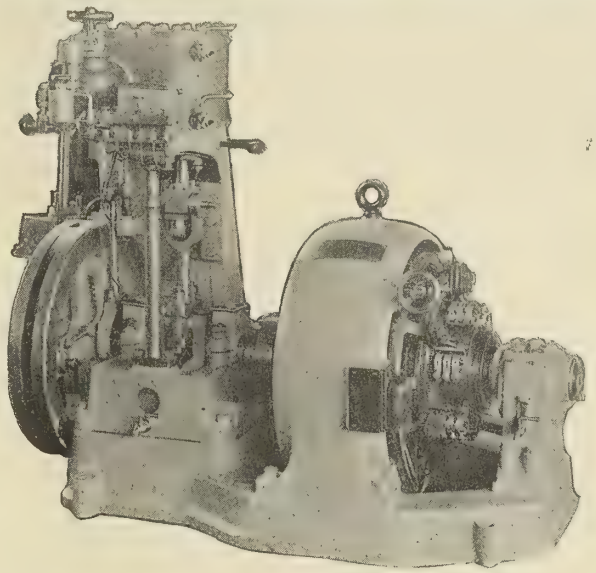


One end of the barrel shaft is provided with a warping drum. The motor, totally enclosed, is bolted direct to the baseplate and drives the barrel through a train of machine-cut spur gearing, the pinions being of mild steel, and where possible forged solid with the shaft. The brake drum is fitted to the motor spindle, the brake being of the band type, applied by a weighted lever and released by a double solenoid, so that the brake automatically applies itself when the circuit is broken and is released when the motor is started. In order to prevent the too sudden application of this brake a dashpot is fitted to the brake lever.

A special feature of the winch is the patent "slipper wheel" device in the train of gearing, consisting of a spur rim clamped between the two side plates by means of spring washers and arranged to slip in the event of the load on the barrel exceeding the normal, thus protecting the gearing and motor. Another important feature is that the bearings are self-aligning. The controller is of the tramway type, bolted direct to the baseplate and complete with separate resistances.

Direct-Driven Electric Light Sets.

An engineer would enjoy the study of the Messrs. Clark & Chapman, Ltd., engines, as shown on the illustration which we give. Here is found a most compact plant, which can be set almost anywhere on board a ship, and this company produces not only the open type, but inclosed type, which is preferable



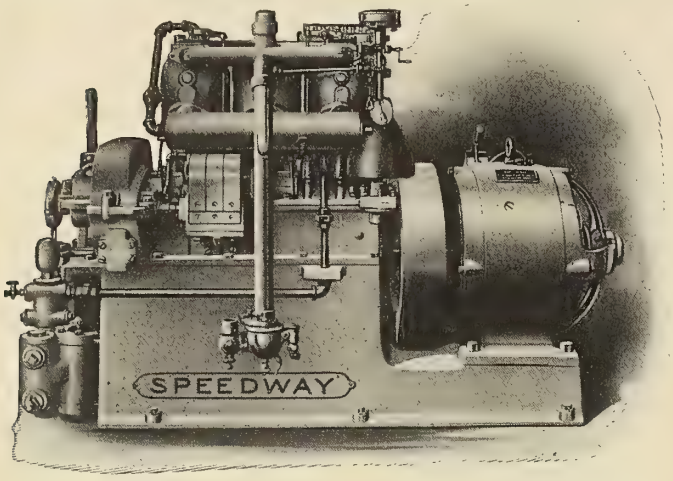
under certain conditions. It is always a question whether we want everything in the engine line where we can see it and get at it, or whether it is best to have it entirely inclosed. The inclosed engines of this company take but a moment to strip them of their covering, and then it is to be remembered that the care which has been given the design and the excellent workmanship used, and material selected, reduce to a minimum the necessity of more than an occasional touch on the bearings and constant and proper lubrication.

While the turbine engines are very popular for electric drive, we notice that the reciprocating engine of this type holds its own, especially where vessels have to go long distances and opportunities for repair of the steam turbines would, of necessity, be limited.

12 K. W. Speedway Gasolene Lighting Set.

This set is built by the Gas Engine & Power Company and Charles L. Seabury & Company, New York, for service aboard large yachts requiring considerable electrical power for winches, sail hoists, searchlights, etc. It is light and occupies small space, which is an advantage not only for marine work but in many stationary installations. The motor is four-cylinder, four-cycle, 6-inch bore by 6-inch stroke, being exactly the same as a regular Speedway marine motor of the same size. A few distinguishing points about the motor are as follows: Valves all operated by a single cam shaft, inlet being over the exhaust in a single-sided cylinder. The inlet is operated by a push rod and rocking lever. Valves are all solid steel, the inlets working in cast iron cages which are arranged for easy removal. All cams, rollers and pins sub-

ject to excessive wear are case-hardened. Pistons are fitted with five spring rings and made light to eliminate vibration. Connecting rods are drop-forged steel. The upper ends are fitted with phosphor bronze bushings. The lower ends are the regular marine type, with bronze babbitted boxes. Cyl-



inders are ground standard and pistons are ground slightly taper, small at the top to allow for expansion. Ignition is the jump spark type, with current supplied by a high tension Bosch magneto. The motor is fitted with a nine-feed-forced feed oiler, a water-jacketed exhaust manifold, and Pickering governor driven from the cam shaft. This governor acts upon the throttle of an 1¼-inch Kingston carburetor, regulating to within 2½ percent between full load and no load.

Coupled direct to the motor is a Diehl 110-volt generator, wound for 600 revolutions per minute. The weight of this set is 2,400 pounds, and it occupies a floor space of 6 feet 6 inches by 2 feet 2 inches. The total height is 3 feet 8 inches.

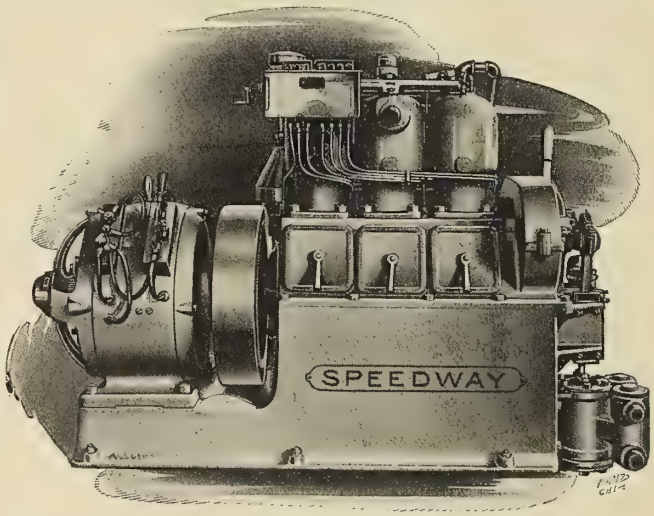
An Engine Indicator.

What the engines are doing after a signal has been set from the bridge is made instantly known by the McNab indicator. This little appliance is being made by the McNab British Indicator Company, Queens Insurance Building, Liverpool, also in Bridgeport, Conn. It has the great advantage of being very simple, consequently reliable, and far from expensive either to buy or install. All there is to it is a small air pump attached to the reciprocating part of an engine, or by an eccentric if a turbine is used. The air pump is led up to an indicator in the pilot house, or anywhere on the bridge or alongside by ⅜-inch piping. The following is an explanation of how this valuable instrument works:

The engineer on receiving the signal to go ahead first throws his valve gear in the ahead position, and as the small indicator cock is attached to the valve gear he automatically opens the port on the indicator cock. The engineer then opens the stop valve, which starts the main propelling engine. This starts the agitator, which is connected to the engine, and works in unison. At every revolution of the propelling engine the agitator forces the air along the single air pipe through the cock, and then along the pipe corresponding to the direction of the flow. The displacement of air enters under the small piston. In the indicator glass tube, which drives it to the top of the tube at each revolution of the engine, indicating every rise and fall of the engine piston ahead or astern and registering every revolution. The ahead and astern indicators operate the same, only the direction of air is automatically altered from one to the other as the engine is reversed.

Oerlikon Electro-Hydraulic Portable Riveter.

This production of Maschinenfabrik Oerlikon, Switzerland, is credited with driving one thousand ¾-inch rivets in ten hours with three men, one at the machine and two bringing up and handling material. The apparatus can be employed either in shops or one outside construction work. It can be slung into any conceivable position on the crane hook, and it makes the work very easy to accomplish. No compressed air or hydraulic pipes are required, nor any pumping installations. The Oerlikon riveter, it can be seen, is independent of locality. It can be used wherever a flexible cable may be connected by means of an ordinary plunger switch to

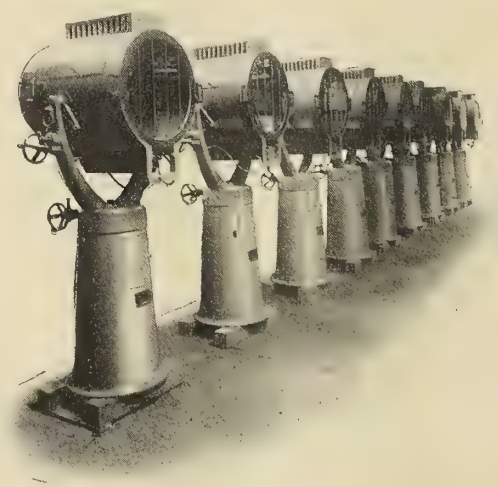


an electric supply circuit. It is, therefore, adaptable for any standard or special jobs in factories or on outside work.

The riveter, combining prime mover and plunger in one apparatus, is tested at the works and carefully adjusted, and is therefore ready for use immediately on delivery, either in shops or on outside work—an additional advantage to commend it to users.

Siemens Brothers Searchlights.

A searchlight is an article which must be absolutely reliable or it is valueless. Messrs. Siemens Brothers Dynamo Works, Ltd., London, make one which has this prerequisite. In the

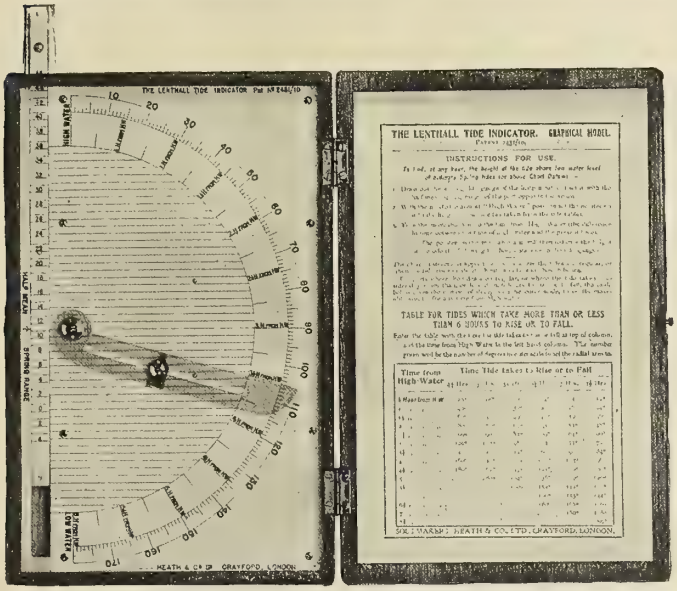


construction of the mirrors used in them the very best material is employed, and the workmen who are producing the lamps are thoroughly skilled in all operations from end

to end. The company supplies all styles and types of searchlights, and their business has reached its present proportion by the closest study of what is required and the ability to produce what is wanted in a thoroughly workmanlike manner. No detail has been overlooked, from the automatic feed mechanism to the ventilation of the lamp and insulation of the wires. The company is supplying the British Admiralty and War Office as well as foreign governments with their searchlights.

A New Nautical Instrument.

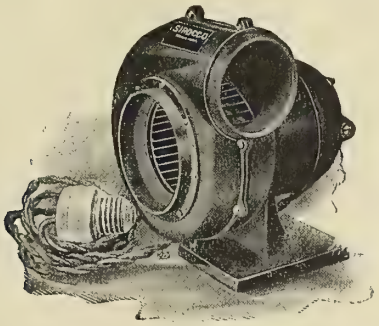
A tide indicator, put on the market by Messrs. Heath & Company, Ltd., of Crayford, London, is something marine men will appreciate in the highest degree, as by its use, almost at a glance, the water level above low water is shown without any calculations whatever. The instrument is made


THE LENTHALL TIDE INDICATOR. GRAPHICAL MODEL.
INSTRUCTIONS FOR USE.
TABLE FOR TIDES WHICH TAKE MORE THAN OR LESS THAN 6 HOURS TO RISE OR TO FALL.
Time from High Water
Time Tide takes to Rise or to Fall
HEATH & CO. LTD. CRAYFORD, LONDON.

in two styles, one of which we illustrate. As a proof of the reliability of the tide indicator, we might mention the fact that one has just undergone a practical test, extending over several weeks, on one of the steamships of the Trinity House, London, with very favorable results.

Ventilating Fans.

There is a growing appreciation of the advantages of good ventilation, so that there is an increasing demand for simple and inexpensive devices for the ventilation of staterooms, cabins, ticket offices, lavatories, toilets, kitchens and dining



rooms aboard ship. This demand is met by the Sirocco electric utility blowers, manufactured by the American Blower Company, Detroit, Mich.

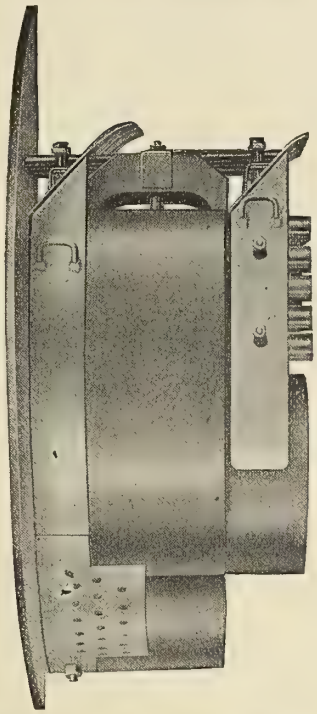
These little blowers can be used as "buzzers," simply stirring up the air, adding to the comfort of the occupants of a room by keeping it in motion, or they can be so installed as to bring in fresh air from outside; or, on the other hand, to exhaust the foul air from the apartments. These small sets are valuable also in shipyard equipment for a variety of uses, such as cooling and ventilating small offices, engine rooms, boilers during repairs, and overloaded motors.

Because of the high mechanical efficiency of the Sirocco turbine type wheel, the electric current consumption is so small as to be almost insignificant. The smallest of these blowers uses less than half the current consumed by an ordinary electric lamp.

The Ross-Schofield Marine Boiler Circulator.

Many attempts have been made to promote circulation of water in marine boilers. The Ross-Schofield Circulator, manufactured by the Ross-Schofield Company, 39 Cortlandt street, New York, is the latest device to be put on the market for this purpose. Our illustration shows the furnace and combustion chamber of a Scotch marine boiler equipped with this system, in the installation of which no part of the boiler is drilled or otherwise damaged.

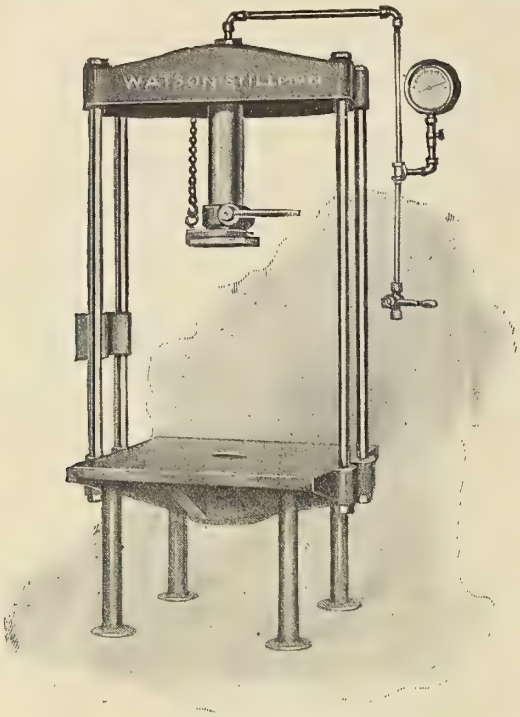
It consists of a steel plate, supported on the short stays,



completely enclosing the water space back of the combustion chambers, except at the top and between the furnaces at the bottom; steel plates, supported by the tubes, placed in front of the combustion chambers and on each side of each furnace or bank of tubes; a back hood and a front hood. Two spaces are thus provided, which operate in parallel, their superimposed curved hoods promoting longitudinal and elliptical circulation of the water by utilizing the natural force of the steam bubbles. These bubbles, passing up through the guiding compartments and issuing from the curved hoods, throws the ascending streams of water in a horizontal direction, eliminating the vertical mechanical projection of water particles, and promoting a flow which continuously draws the water from the lower and colder part of the boiler up between the guiding plates, thence propelling it longitudinally toward the front, rapidly establishing constant and effective circulation, which is maintained. The mammoth *Titanic*, among other trans-Atlantic ships, is equipped with this circulator. One company alone has ordered fourteen equipments.

Watson-Stillman Hydraulic Press.

The Watson-Stillman Company, New York, has added to its line another hydraulic press which is specially adapted to forcing bearings, but is also a handy tool for general machine shop use. The weight shown on the left counterbalances



the ram, which can be handled independently of the pump by means of a rack, pinion and lever arrangement. A hole through the platen permits work to be projected or forced through. The capacity of the press reaches its maximum of 30 tons under a hydraulic pressure of 6,250 pounds per square inch, which may be produced by using either a hand or belt-driven pump attached to the pipe the cut shows. The length of stroke of the ram is 18 inches, and its diameter is 3½ inches. An 18-inch stroke suffices for most press fitting. So long a stroke is often desirable because it increases adaptability of the press.

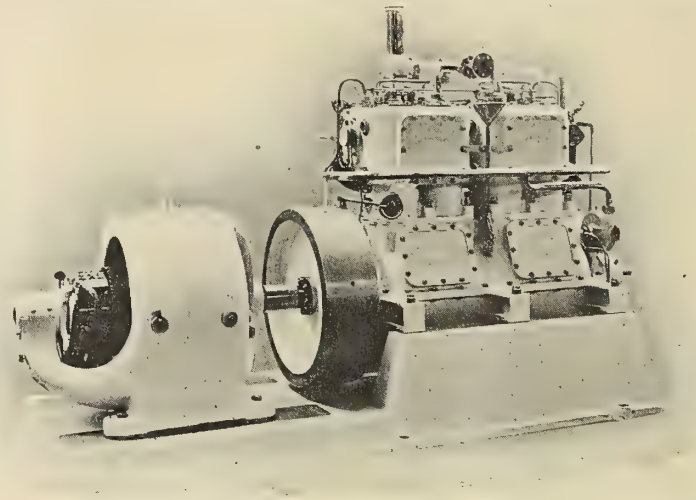
Steam Turbine Outfits for Electric Generation.

The turbine dynamos which Messrs. Greenwood & Batley, Ltd., Leeds, are supplying ships, yachts, etc., employ the De Laval system of turbine, which they own for England, for their drive. A late catalogue, just received, shows some very interesting and neat electric lighting sets, which will appeal to marine men on account of the small space they take up, their general appearance, and, above all, their reliability. This company does not build De Laval turbines above 600 brake-horsepower, but is prepared to furnish any output below the powers named, down to even as small power as 3 brake-horsepower.

Thornycroft Motor-Driven Power and Electric Light Plants.

John I. Thornycroft & Company, Ltd., London, are offering a complete line of centrifugal pumps and electric plants which are run by internal combustion engines. The lighting outfits have an electrical output of from 3.5 kilowatts up to 45.5 kilowatts, and their pumping outfits have a discharge of from 110 gallons per minute to 1,800 gallons per minute.

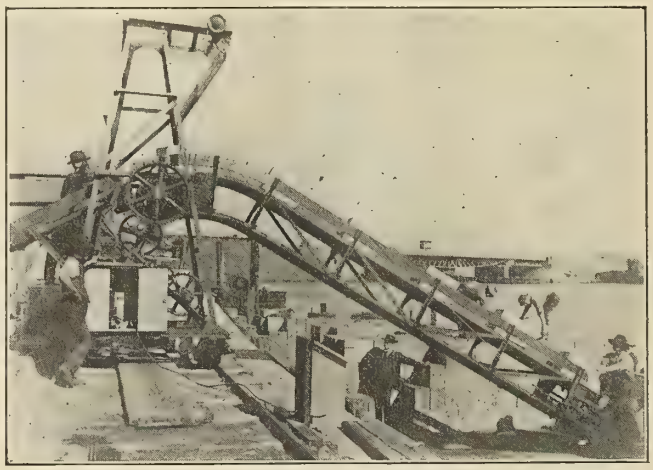
We illustrate an electric lighting set which, in the 3.5 kilowatt size, would measure 64 inches long, 40¼ inches wide and stand 20 inches high, while for the larger sizes named the measurements would be 146 inches long by 43 inches wide by 72 inches high. The combination of pump and generator, which is turned out by this firm, is one which should attract the attention of naval architects on account of its compactness, as this feature will make it most valuable not only for small vessels but for ships of all sizes. The John I. Thorny-



croft & Company are noted for their care of detail, and in such plants as we have referred to every precaution has been taken to eliminate things that are trappy, and most reliable outfits are the result.

Freight Handled Mechanically.

The accompanying view shows a Jeffrey portable conveyor which has been installed for the Vacuum Oil Company for delivering outgoing and receiving incoming light freight at the Sydney, Australia dock. This machine constitutes an unique freight-handling plant, electrically driven, with 1½-horsepower motor, capable of handling 1,000 cases or light packages per hour. The length of the boom is approximately 24 feet, and it is so arranged that it can be raised or lowered as may be necessary on account of the tide. The portable truck carrying the boom travels on a track extending the

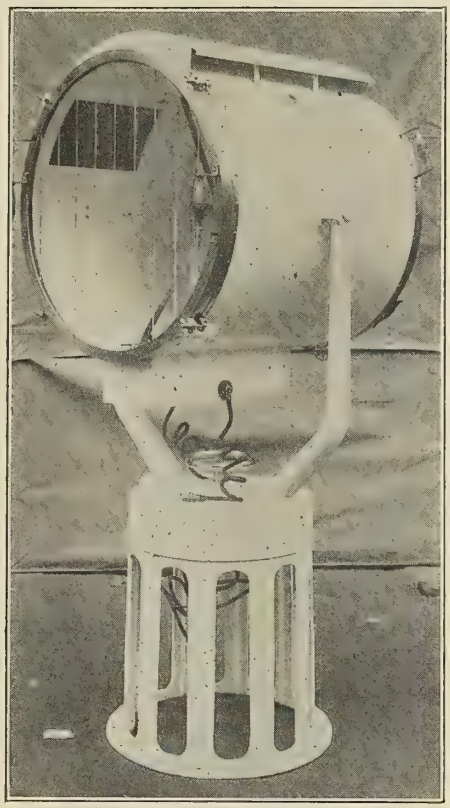


entire length of the dock, allowing the machine to be placed at the most convenient point for unloading, or loading, as the case may be. This boom is equipped with a continuous-moving Jeffrey conveyor belt. It is upon this belt that the outgoing freight is delivered; the cargo placed on the belt by human labor descends to the barge, from where it is again handled and piled. The view shows the boom lowered, and gives a clear idea of the method of unloading. The boxes

travel along on the belt and are delivered automatically to the waiting drays. This method has minimized labor, and is claimed to have reduced the cost of handling at least 50 percent. This machine was furnished by the Gibson, Battle Company, Sydney, Australia, agents for the Jeffrey Manufacturing Company, Columbus, Ohio.

Searchlights.

The Carlisle & Finch Company, Cincinnati, Ohio, besides making most admirable searchlights for marine use, can supply them for many other purposes, where a long-continued run is necessary, such as guarding wharves, furnishing light for loading or unloading vessels. Our illustration shows a 32-inch deck projector, but the company makes these up to a diameter of 38 inches and in endless variety of types, applic-



able to all styles and descriptions of vessels, and even for small launches. Carbon-fitting mechanism is very sensitive and the carbon carriers are supported on two parallel brass rods, and are moved towards each other by means of a right and left screw. This screw is actuated by a shunt magnet, and the length of the arc is maintained absolutely uniform, no matter in what position the mechanism is placed. No other projector possesses such an accurate and reliable method of feeding the carbons together as they are consumed.

All parts of the mechanism are below the metal shield, and the slender carbon holders are the only parts which are in the line of the light.

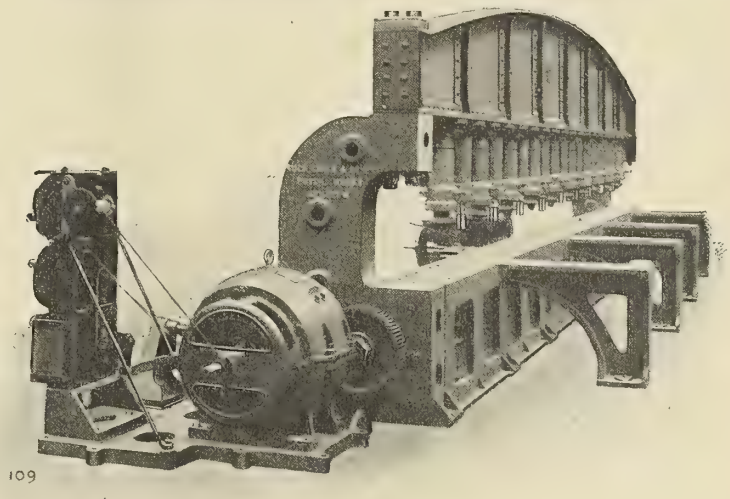
E. M. I. Cabin Fans.

Messrs. Hogan & Wardrop, of London, are making cabin fans which are designed with special care in order to take up as little headroom as possible, as this, of course, is of prime importance in ship work. The feature of these fans is the ease with which they can be attached and detached by simply turning the thumb nut. In many English ships the cabin fans are hired to the passengers for the trip and are not furnished, as is common on some lines. This point of detachability, therefore, is most advantageous. By means of the same thumb nut the angle of the fan can be changed so as to deliver air in any direction, and the volume of the air delivered can be evenly regulated, so there is no need of having either a storm or a dead calm, and this feature will be most highly appreciated by all who travel in warm climates.

Electric Drive for Shipyard Tools.

The patent electric drive for machines, as made by Messrs. Vickers, Ltd., Sheffield, claims many advantages, the chief being that the motor itself reverses and is directly geared to the driving screw or rack wheel of the machine. Other advantages can be stated as follows:

Absence of all trouble due to the use of belts; perfect control over the cutting speeds; increased output is obtained owing to the control of cuts; dispensing with a good deal of the mechanical gear which would otherwise be necessary.



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The system is applicable for driving all classes of reciprocating tools, including every type of planer and large slotting and shaping machines. Messrs. Vickers, Ltd., have converted plate edge planers cutting both ways up to 60 feet per minute and table planers of all sizes from 3 feet 6 inches to 12 feet wide. We illustrate a plate edger fitted with the drive.

Brush Electric Lighting Set.

The Brush Electric Lighting Set is manufactured by the Charles A. Strelinger Company, Detroit, Mich. It consists of the Brush balanced two-cylinder, internal-combustion type of engine, direct connected to generator. The outfit is very compact and complete, including switchboard and all necessary instruments and ignition apparatus. Either gasoline (petrol) or kerosene may be used as fuel.

The regulation obtained is believed to be decidedly better than that of the average steam engine. The current may be used not only for lighting but for heating, cooking, pumping, ventilating and many other purposes. A plant of this kind is especially desirable to have as a reserve on vessels where wireless apparatus is used. Its compactness permits installation almost anywhere on an upper deck to be utilized in case of mishaps to the regular power plant.

The accompanying picture shows the launch *Calcite*, of Seattle. This is equipped with a Brush Electric Lighting Set, which not only furnishes electric light but the current for

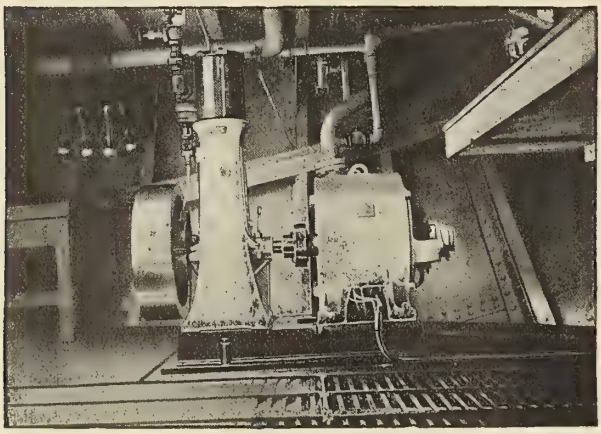
searchlights, four electric heaters and electric cooking apparatus. This launch is of heavy construction; is used for towing barges, sailing vessels, etc.; picking up logs, protecting

booms; also for transportation and pleasure purposes. The outfit is said to be giving excellent satisfaction, operating in the most quiet manner, being run by the regular ship's crew, none of whom is familiar with gas engines.

Lighting Set.

Lighting sets consisting of vertical self-oiling engines direct connected to standard makes of electric generators are placed on the market by the American Blower Company of Detroit, Mich. The enclosed frame of the engine protects it from dust and dirt, and as the enclosing panels are easily removed by simply turning a milled hand nut, the working parts are as readily accessible as in an open frame engine. These sets weigh inside of one pound for every 3½ watts output, which is as light as any engine can be made and still have ample strength for long and continuous service as is demanded aboard ship.

The engines used in connection with these lighting sets

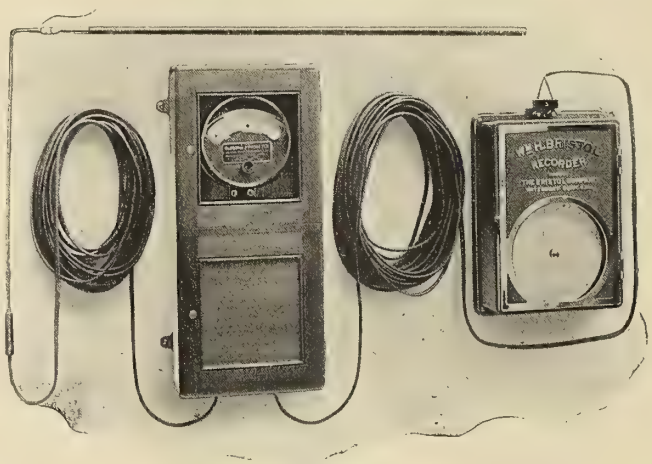


differ from all others in the system of lubrication employed. Every frictional surface is running on oil, there being no possible contact between metals, with the effect of almost eliminating wear. They will run for months on the initial supply of oil and without adjustments. The oiling is done by the engine itself. At the base is located a small pump, which even at the slowest speed delivers to each moving part a copious stream of clean oil. The oil flows by gravity to the running parts, and in returning to the base of the engine is filtered and cooled before being repumped. No oil is wasted, and this system insures a saving of four-fifths of the usual cost of lubrication.

Combination Indicating and Recording Pyrometers.

Engineers are quickly learning that the pyrometer has become a necessity in the heat treatment of steel. The thermo-electric pyrometer is the one which is most generally in use. It depends for its operation upon the phenomenon that if two dissimilar metals or alloys are joined and their junctions are at different temperatures an electric current is produced, flowing through the metals. Thus the electromotive force is a function of the difference of temperature between the hot and the "cold end" of the couple. It is, therefore, necessary that the couple should be made of sufficient length to carry the cold end beyond the influence of the radiation of heat from the furnace and the conduction along the thermo-couple and its protecting tubes.

In practice where the thermo-couple is extended a novel feature is that of separating the thermo-couple into two parts, one of which is called the fire end and the other the extension piece, these parts being joined together as near as practicable to the point where the thermo-couple passes



through the wall of the furnace in which the temperature is to be measured. The advantages of this separable junction are obvious, as it makes it possible to renew the fire end at a minimum of cost, and it also permits carrying the cold end to a point where the atmospheric temperature will remain practically uniform.

When very accurate readings are required an automatic compensator may be placed at the cold end. This compensator consists of a glass bulb with a short stem similar to an ordinary mercury thermometer. Two platinum wires are fused into same near its tip. These are connected within the flattened bore by a loop of platinum wire, thus completing the circuit. It will be seen that the resistance is increased or decreased as the mercury falls or rises. When the temperature falls at the cold end, the resistance in the compensator being increased, it prevents an increase in the electromotive force of the couple, and vice versa.

The illustration shows a combination of an indicating and recording thermo-electric pyrometer. It consists of a single fire end and extension piece connected to the indicating and recording instruments by suitable lengths of flexible duplex leads The fire end or thermo-couple is applied in the furnace at the point where the temperature is to be measured and the indicating instrument is placed at a point where the operator may easily view it; while the recorder can be placed in the

superintendent's office several hundred feet away. These combinations are being used extensively, as they fill two requirements: First, they instruct and guide the furnace operator regarding the temperature at which he is running; and, secondly, they furnish the superintendent with a continuous record of those same temperatures and a check on the faithfulness of the operator in properly controlling them. These pyrometers are also made in portable form with special couples for taking temperatures of furnaces, flues, molten metal, etc. The above instruments and a complete line of recording instruments for temperature, pressure and electricity are made by The Bristol Company, of Waterbury, Conn.

PERSONAL.

A. L. Hopkins, who has been assistant manager of the Newport News Shipbuilding & Dry Dock Company, Newport News, Va., has been made manager by the promotion of Mr. Walter A. Post from manager to president.

Capt. C. O. Tilton, for many years connected with the Atlantic Transport Line, has been made commander of the auxiliary naval vessel *Vestal.*

The delegates appointed to represent the Society of Naval Architects and Marine Engineers to attend the Jubilee of the Institution of Naval Architects, London, are as follows: Rear Admiral H. I. Cone, U. S. N.; Rear Admiral R. M. Watt, U. S. N.; J. R. Andrews, Charles Ward, Commander M. E. Reed, U. S. N.; Prof. William Hovgaard, E. P. Bates, M. S. Chace, Prof. C. H. Peabody and H. L. Aldrich.

TECHNICAL PUBLICATIONS.

Engineering Descriptive Geometry. By F. M. Bartlett, Commander, U. S. N., and Theodore W. Johnson, A. B. M. E., Professor of Mechanical Drawing, United States Naval Academy. Size, 6 by 9 inches. Pages, 159. Illustrations, 137. United States Naval Academy. Price, $1.50.

This work of Commander Bartlett and Professor Johnson seems to us to be ideal in its simplicity and clearness. It is so difficult for most minds to think in more than two planes, and probably the student is more embarrassed by trying to understand descriptive geometry than by any other branch of mathematics.

The few errors in the first edition have been corrected and some of the drawings have been modified. We have tried to write something which would give an idea of the true value of this book, but we find we cannot do better than copy from the preface of this work, and we compliment most heartily the authors. It says:

The aim of this work is to make Descriptive Geometry an integral part of a course in Mechanical or Engineering Drawing.

The older books on Descriptive Geometry are *geometrical* rather than *descriptive.* Their authors were interested in the subject as a branch of mathematics, not as a branch of drawing.

Technical schools should aim to produce engineers rather than mathematicians, and the subject is here presented with the idea that it may fit naturally in a general course in Mechanical Drawing. It should follow that portion of Mechanical Drawing called *Line Drawing,* whose aim is to teach the handling of the drawing instruments, and should precede courses specializing in the various branches of Drawing, such as Mechanical, Structural, Architectural and Topographical Drawing, or the "Laying Off" of ship lines.

The various branches of drawing used in the different industries may be regarded as dialects of a common language. A drawing is but a written page, conveying by the use of lines a mass of information about the geometrical shapes of objects impossible to describe in words without tedium and ambiguity. In a broad sense, all these branches come under the general term Descriptive Geometry. It is more usual, however, to speak of them as branches of Engineering Drawing, and that term may well be used as the broad label.

The term Descriptive Geometry will be restricted, therefore, to the common geometrical basis or ground work on which the various industrial branches rest. This ground work of mathematical laws is unchanging and permanent.

The branches of Engineering Drawing have each their own abbreviations and special methods adapting them to their own particular fields, and these conventional methods change from time to time, keeping pace with changing industrial methods.

Descriptive Geometry, though unchanged in its principles, has recently undergone a complete change in point of view. In changing its purpose from a *mathematical* one to a *descriptive* one, from being a training for the geometrical powers of a mathematician to being a foundation on which to build up a knowledge of some branch of Engineering Drawing, the number and position of the planes of projection commonly used are altered. The object is now placed behind the planes of projection instead of in front of them, a change often spoken of as a change from the "1st quadrant" to the "3d quadrant," or from the French to the American method. We make this change, regarding the 3d quadrant method as the only natural method for American engineers. All the principles of Descriptive Geometry are as true for one method as for the other, and the industrial branches, as Mechanical Drawing, Structural Drawing, etc., as practiced in this country, all demand this method.

In addition, the older geometries made practically no use of a third plane of projection, and we take in this book the further step of regarding the use of three planes of projection as the rule, not the exception. To meet the common practice in industrial branches, we use as our most prominent method of treatment, or tool, the use of an auxiliary plane of projection, a device which is almost the draftsman's pet method, and which in books is very little noticed.

As the work is intended for students who are but just taking up geometry of three dimensions, in order to inculcate by degrees a power of visualizing in space, we begin the subject, not with the mathematical point in space but with a solid tangible object shown by a perspective drawing. No exact construction is based on the perspective drawings which are freely used to make a realistic appearance. As soon as the student has grasped the idea of what orthographic projection is, knowledge of how to make the projection is taught by the constructive process, beginning with the point and passing through the line to the plane. To make the subject as tangible as possible, the finite straight line and the finite portion of a plane take precedence over the infinite line and plane. These latter require higher powers of space imagination, and are therefore postponed until the student has had time to acquire such powers from the more naturally understood branches of the subject

F. W. B.
T. W. J.

The Care, Operation and Management of the Parsons Marine Steam Turbine. By W. C. Nixon, Ensign U. S. N. Size, 6 by 9½ inches. Pages, 216. Illustrations, 20. United States Naval Academy, School of Marine Engineering, Annapolis, Md., 1911. Price, $1.50.

Another book on steam turbines would seem to most of those who have been interested in this subject a work of supererogation, but we will say that Mr. W. E. Nixon has given to his brother engineers the most interesting and instructive book that has yet been brought out on turbines. There is nothing in it mathematical, it is true, but the mathematics of

the steam turbine have been pretty fully discussed. But from beginning to end it shows how thoroughly well versed is the author in handling turbines and what a gift he has in imparting his knowledge. The work treats only of Parsons turbines as fitted in the ships of the United States navy. It not only tells what the turbine should do but what it actually does that it should not, and, above all, how and what to do to correct the trouble if anything goes wrong. No clearer and more concise descriptions seem to us possible. The author is a member of the School of Engineering at Annapolis, and it certainly bodes well for this school that such a valuable production should emanate from it. We might add that this school of engineering is not for the cadets but for graduated officers after service both at sea and on land.

A Textbook on Steam and Steam Engines. By Andrew Jamieson, M. Inst. C. E. Size, 6 by 8 inches. Pages, 828. Numerous illustrations and tables. London, Charles Griffin & Company, Ltd. New York, 1910: D. Van Nostrand & Company. Price, $3.50.

The test of a work such as has been produced by Mr. Jamieson is found by daily turning to it for information. Such a test we have made and not found it wanting. In many ways the book warrants commendation. It is clear in its statements; admirable in its arrangement, each subject being kept by itself, and one does not have to turn back and forth in order to assemble the full information wanted. The examination papers and information concerning them is most interesting and valuable to applicants who are going up for examination before various boards. The work is up to the practice of to-day, and the history of steam is given most fully. Recognizing the value of the eyes in assisting to grasp explanations, illustrations have been used in profusion. We recall no book which has impressed us more, and we could say with truth that it is almost a library in itself of applied mechanics.

SELECTED MARINE PATENTS.

The publication in this column of a patent specification does not necessarily imply editorial commendation.

American patents compiled by Delbert H. Decker, Esq., registered patent attorney, Loan & Trust Building, Washington, D. C.

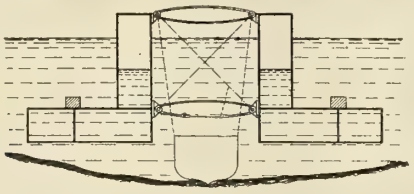
British patents compiled by G. E. Redfern & Company, chartered patent agents and engineers, 15 South street, Finsbury, E. C., and 21 Southampton Building, W. C., London.

19,173. OTTER BOARDS FOR TRAWL NETS. C. W. BROMPTON, GRIMSBY.

The otter board of this invention travels nearly in the direction of its length, the spreading action for the net being obtained by means of a hinged flap whose opening is limited by chains. The resistance to towing, due to lateral drag on the sea floor, is thus obviated.

18,535. FLOATING DOCKS AND MEANS FOR RAISING OR SALVING SUNKEN SHIPS, ETC. P. VON KLITZING, KIEL, GERMANY, ENGINEER-IN-CHIEF.

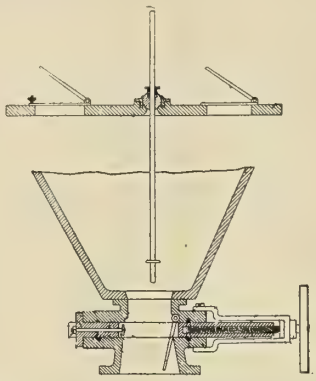
According to this invention two floats are connected at their upper ends in such wise that their distance apart can be varied for raising



a sunken vessel. The lifting ropes along one side are suspended from pulleys carried in bights in a common rope which passes over pulleys along the top of the float and is hauled in by winches for raising the vessel. Thus the strains on all the lifting ropes are equalized. Separately, the floats can be used for docking ships.

6,836. ASH EJECTOR SLIDES OR VALVES. W. C. KEENE, LIVERPOOL.

A sluice valve for ash ejectors comprises a plate working within a casing, having packing-grooves arranged across the working surfaces of the plate so that asbestos packing or the like can be compressed in the grooves by the screws. Ashes are fed into the hopper through



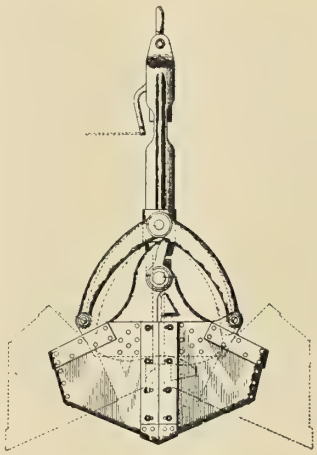
closable openings and fall upon the flap closed to cover the plate. On opening the latter the flap drops and allows water to enter as usual.

990,596. SEA ANCHOR. J. A. ROSVOLD, DEC'D. J. B. JACOBSEN, ADM., NOME, ALASKA.

In combination, a wave breaker adapted to float upon the surface of the water, a plurality of sea anchors connected in series, the first of the series being attached to said wave breaker, and the last of the series having a greater effective area composed of a rectangle with triangle attached to one side.

989,832. BUCKET. JAMES L. BUTLER, OF ALLIANCE, OHIO.

In a device of the character described, the combination of a pair of pivotally connected bucket members, a bucket support, a bucket actuating device slidably mounted upon the support and associated with the



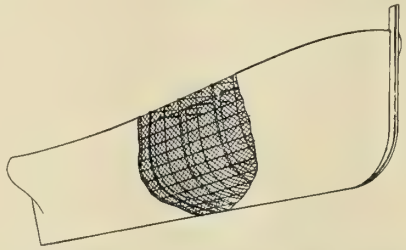
pivotal connection of the bucket members for raising and lowering said pivotal connection, and means carried near the upper end of said support for engaging the upper end of said bucket actuating device and locking the same to the support.

991,545. STEERING MECHANISM. FREDERICK ROUISS, OF JERSEY CITY, N. J.

A steering mechanism provided with a post, a wheel mounted on the post, and including a hub and spokes, the spokes being bent at their inner ends and having their outer ends arranged in the same horizontal plane as the rim of the wheel, a spider including a hub and pairs of diverging arms that straddle opposite spokes of the wheel, the arms at their inner ends, being beveled to correspond with said inclination at the inner ends of the spokes with the outer ends of the arms from the inclined parts of the spokes lying in the same horizontal plane as the wheel, and cushioning means having engagement with said arms and with the spokes that said arms straddle.

991,780. CONCRETE FLOATING BODY. A HOLM. CAMDEN, N. J.

A floating body having a skeleton frame formed with projecting eyes,



a network through which said eyes project, rods passing through said eyes over said network, and a cement cover arranged over said network and rods.